CR 92.011

NCEL

Contract Report

August 1992

An Investigation Conducted by
EG&G Idaho, Inc.

ADVANCED TRANSFORMER DEMONSTRATION AND VALIDATION PROJECT SUMMARY REPORT BASED ON EXPERIENCES AT NAS, NORTH ISLAND, SAN DIEGO, CA

Abstract The Idaho National Engineering Laboratory and the Naval Civil Engineering Laboratory (NCEL) participated in an advanced transformer demonstration and validation program. The key objectives of the Advanced Transformer Demonstration and Validation Project were to verify the operational characteristics of advanced transformer technologies, determine their applicability to Navy use, and provide NCEL with lessons learned in the installation of these transformers at an active Navy base.

Ten new transformers were installed on the Naval Air Station (NAS), North Island, CA. These special advanced technology units replaced polychlorinated biphenyl-filled units in and around buildings onNAS, North Island. The new transformers included cast coil, amorphous core, and vacuum pressure impregnated units. This report summarizes the experiences gained during the NAS, North Island advanced transformer demonstration and validation project.

NAVAL CIVIL ENGINEERING LABORATORY PORT HUENEME CALIFORNIA 93043-5003

METRIC CONVERSION FACTORS

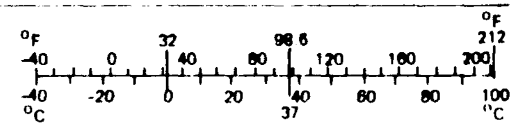
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2,000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, [illegible] Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1,000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-018

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
August 1992

3. REPORT TYPE AND DATES COVERED
Final; 1 Oct 1988 - 31 May 1992

4. TITLE AND SUBTITLE
ADVANCED TRANSFORMER DEMONSTRATION AND VALIDATION PROJECT SUMMARY REPORT BASED ON EXPERIENCES AT NAS, NORTH ISLAND, SAN DIEGO, CA

5. FUNDING NUMBERS
PR - 74-021 (PWCS.D)
C - N68305-89-WR-00028
N68305-89-WR-00160
WU - DN669075

6. AUTHOR(S)
Scott McBride

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESSE(S)
Idaho National Engineering Laboratory
EG&G Idaho, Inc.
Idaho Falls, Idaho 83415

8. PERFORMING ORGANIZATION REPORT NUMBER
CR 92.011

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESSE(S)
Navy Public Works Center / Naval Civil Engineering Laboratory, Code L74
San Diego, CA 922136-5113 / Port Hueneme, CA 93043

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The Idaho National Engineering Laboratory and the Naval Civil Engineering Laboratory (NCEL) participated in an advanced transformer demonstration and validation program. The key objectives of the Advanced Transformer Demonstration and Validation Project were to verify the operational characteristics of advanced transformer technologies, determine their applicability to Navy use, and provide NCEL with lessons learned in the installation of these transformers at an active Navy base.

Ten new transformers were installed on the Naval Air Station (NAS), North Island, CA. These special advanced technology units replaced polychlorinated biphenyl-filled units in and around buildings onNAS, North Island. The new transformers included cast coil, amorphous core, and vacuum pressure impregnated units. This report summarizes the experiences gained during the NAS, North Island advanced transformer demonstration and validation project.

14. SUBJECT TERMS
Advanced transformers, non-PCB transformers, cast coil, amorphous core, vacuum pressure impregnated units

15. NUMBER OF PAGES
325

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18
298-102

CONTENTS

ACRONYMS

INEL	Idaho National Engineering Laboratory
NCEL	Naval Civil Engineering Laboratory
NASNI	Naval Air Station, North Island
PCB	polychlorinated biphenyl
PWC	Public Works Center
VPI/E	vacuum pressure impregnated/encapsulated

ADVANCED TRANSFORMER DEMONSTRATION AND VALIDATION
SUMMARY REPORT BASED ON EXPERIENCES
AT NAVAL AIR STATION, NORTH ISLAND
SAN DIEGO, CALIFORNIA

1. INTRODUCTION

The Idaho National Engineering Laboratory (INEL) and the Naval Civil Engineering Laboratory (NCEL) are cooperatively participating in an advanced transformer demonstration and validation program. This task is part of a polychlorinated biphenyl (PCB) Mitigation and Risk Management Assessment Program being performed at the Naval Air Station, North Island (NASNI) in San Diego, California. This report details the specific lessons learned during the NASNI installations to date and addresses the advantages and disadvantages of these transformers for Navy use.

As a part of this program, eight efficient, low-loss cast coil (CC) dry-type transformers, one vacuum pressure impregnated (VPI) transformer, and one low-loss amorphous core transformer were installed at the NASNI to replace existing PCB-filled transformers. The specific advantages and disadvantages of each type of transformer are discussed in the following sections.

2. BASE HISTORY

The electrical distribution system currently in operation at the NASNI contains several hundred devices, several of which are filled with PCB-filled/contaminated insulating fluid. The continued use of PCBs as a electrical device insulating liquid was outlawed in late 1977, and the NASNI is faced with retrofilling or retrofitting the remaining PCB devices (transformers, capacitors, oil switches, and oil-filled circuit breakers).

The PCB transformers are installed in locations including pole mounts, vaults, and various power distribution system locations; many transformers are located near the ocean. Transformers near the ocean are sensitive installations because of the hazardous location and the extreme environmental risks associated with either transformer fires or leaks involving a PCB liquid-filled device near or over the ocean. Most of the NASNI boundaries are surrounded by water. The salt laden air is very corrosive to electrical devices. These criteria were seriously considered during the replacement process and new transformers were installed that greatly reduced or eliminated the safety and environmental concerns associated with the older PCB-filled units.

The INEL supervised the replacement and load consolidation of 13 PCB transformers with 10 new advanced technology transformers during this portion of the Mitigation and Risk Management Program. The locations and sizes of these units are identified in Table 1.

Table 1. Locations and sizes of transformers installed during the NASNI Advanced Transformer Demonstration and Validation Project

Building	Units Removed[a]	Units Installed[b]	Comments
94	1-500 kVA PCB	1-750 kVA CC	2 for 3 replacement
	2-112.5 kVA PCB	1-300 kVA CC	oil switches removed
342	1-112.5 kVA PCB	1-112.5 kVA CC	1 for 1 replacement
378	1-1000 kVA PCB	1-750/1000 kVA CC	3 for 3 replacement
	2-500 kVA PCB	2-500 kVA CC	
379	3-167 kVA PCB	1-300 kVA VPI	1 3ϕ for 3 1ϕ replacement
472	1-1500 kVA PCB	1-1500 kVA CC	1 for 1 replacement
473	1-112.5 kVA PCB	1-112.5 kVA AC	1 for 1 replacement
489	1-1500 kVA PCB	1-1500 kVA CC	1 for 1 replacement

a. PCB = existing PCB-filled unit.

b. CC = cast coil
AC = amorphous core
VPI = vacuum pressure impregnated.

3. PROJECT SUPPORT AND ADMINISTRATION

The following sections detail several project support tasks and administrative elements that were completed during this project.

3.1 Specifications

Two transformer specifications (EG&G ES-51333 Rev. B and ES-51334 Rev. B) were written by the INEL. Specification ES-51333 details the construction and installation requirements for liquid-filled transformers, and Specification ES-51334 details the construction and installation requirements for cast coil and VPI transformers. Data sheets and design details for each transformer installation were included in both specifications. This enabled the INEL engineering team to make device selections that met the particular facility needs and optimized the research element around which this project was centered. The specifications required the manufacturer to perform some nontypical factory testing on the new transformers, field testing on the old transformers being removed, and field testing on the new transformers being installed to support the ongoing advanced transformer evaluation work. The specifications are included in Appendix A of this report.

Appendix B contains the final acceptance testing reports of the ABB Service Company 112.5 kVA amorphous core transformer, the National Industri cast coil transformers, the Square-D 300 kVA VPI transformer, and transformer schematic drawings.

3.2 Subcontracts

Three subcontracts were awarded during this project. Subcontract No. C90-132540 was awarded to Square D Company for manufacturer and installation of one 300 kVA VPI transformer. Subcontract No. C90-132708 was awarded to ABB Service Company for manufacturer and installation of the nine remaining transformers. Subcontract No. C90-132830 was awarded to Rollins Chempak for destruction of the PCB fluid and transformer carcasses. All certificates of destruction of the PCB fluid and carcasses were issued to the San Diego Public

Works Center (PWC). Appendix C contains operating and maintenance manuals and product information for the transformers and their supporting instrumentation.

3.3 Field Office

An INEL field office was established as part of the PCB Mitigation and Risk Management Program before the transformer installations. This office served as a common point for the manufacturers and their subcontractors to coordinate activities with both the Navy PWC and the INEL and supported coordination with other NCEL tasks being performed concurrently at the NASNI.

3.4 Quality Assurance

Quality assurance is a requirement during both the manufacturing process and installation. The possible consequences of failures caused by poor quality assurance can easily exceed the cost of a consistent quality assurance program. The INEL performed a comprehensive field quality assurance engineering program during the course of this project. The program included supervision during factory testing, field testing, and installation of the new transformers. This program verified that these objectives and specifications of the retrofit program were adequately met.

3.5 Timing and Coordination

The INEL and NCEL were responsible for project and outage coordination and planning. INEL and NCEL coordination for this project was minimized because the contractors delivered a turn-key product. Thus, the riggers, hazardous waste handlers, and installers were coordinated by the prime contractors (manufacturers). The Navy PWC and INEL interfaced with the manufacturers to coordinate the outages and installations.

A majority of this project was conducted during the Persian Gulf Crisis. This contributed significantly to the amount of planning required to complete the changeouts without impacting Base operations. The INEL resident engineers negotiated facility power outages with the Navy PWC and the manufacturers to minimize the impact to the Base. The INEL resident engineers also arranged base access and clearance for the manufacturers and their subcontractors.

3.6 Documentation

These installations removed and replaced PCB-filled devices with new high efficiency, new technology transformers. The PWC has been notified, and it is recommended that both the records of the PWC and the fire department should be updated to reflect the removal of PCBs from these locations.

3.7 Security

Security is a major concern on the Navy Base. Compliance with security measures is mandatory and requires a substantial amount of time. Security on Base was increased substantially during the Persian Gulf Crisis. Proper procedures were followed to arrange for access and clearances for those personnel performing the installations. Advance arrangements reduced delays and made it easier for contractors to obtain access to the installation sites on Base.

Some facilities have minimum levels of security while others are tightly controlled. During this project, all operations went smoothly because of the preplanning and communication with security personnel and the coordination with the Naval Air Rework Facilities and PWC personnel.

4. HARDWARE INSTALLATION

4.1 Building 94

The Building 94 installation consisted of removing three existing PCB-filled transformers (as identified in Table 1) and replacing them with two new cast coil transformers. The three existing units were removed from Building 94; they were located on an overhead mezzanine (Pad 2) approximately 35 ft above finished floor. This installation was performed beginning at 1630 hours on September 26, 1990, and concluded at 1630 hours on September 28, 1990.

Before the outage, the new 750/1000 kVA cast coil dual rated outdoor unit substation transformer with a new 15 kV primary fused switch was set in place on a new concrete pad outside of Building 94. The contractor performed as much electrical work before the outage as the job would allow. This minimized the outage requirements for the installation.

The 750/1000 kVA transformer has a 2400 V/12000 V reconnectable primary winding constructed using five sections. The five sections are connected in series for the 12000 V configuration and in parallel for the 2400 V configuration. Vertical busses mounted external to the coils are used to make the series/parallel connections. High voltage taps are provided on the primary 12000 V configuration only. The unit was installed in the 2400 V configuration by extending the existing 2400 V feeder from the mezzanine to the new outside location. The existing 2400 V distribution systems are currently being upgraded to 12 kV by the Navy. The dual voltage transformers make the transition from 2400 to 12000 V in the facilities more cost effective. New secondary switchgear was also installed on this unit substation to feed the existing loads and the new 300 kVA transformer. The 300 kVA transformer is fed by the 480 V output of the 750/1000 kVA transformer. The secondary voltage of the 300 kVA unit is 208/120 V and will be used to feed one existing 208 V panel and one existing 240 V panel. The INEL addressed the option of providing only 208 V to the 240 V panel with the San Diego PWC. The PWC stated that all existing 240 V loads would operate acceptably at the reduced voltage.

This installation presented the contractor with several unique difficulties. Most importantly, the existing PCB-filled transformers were located approximately 35 ft over an aircraft rework facility. Extreme care had to be taken to protect the adjacent aircraft and shop equipment from any physical or environmental damage while removing the hazardous waste (liquid and solid) and installing the new electrical equipment. In addition, with the conflict in the Persian Gulf, the operations of this aircraft rework facility were intensified. This placed added pressure on the construction crew to minimize outage and installation time. Extensive planning was needed to avoid problems and outage extensions that would have caused significant impact to the facilities operations.

In spite of several interim problems that were encountered during this installation, ABB Service Company was able to react quickly to the directions of the Navy and the INEL field engineer to successfully complete the task.

4.2 Building 342

The Building 342 installation consisted of removing an existing 112.5 kVA PCB transformer and replacing it with a new 112.5 kVA cast coil unit substation transformer with a dual voltage primary winding (2400 and 12,000 V). The existing oil fused cutouts were also removed and replaced with a new 15 kV fused switch. This installation was performed beginning at 0600 hours on December 15, 1991, and concluded at 0600 hours on December 16, 1991.

The new transformer was initially installed in the 2400 V configuration. The dimensions of the new transformer required that the concrete pad be extended and the safety fence be modified. The concrete and fence work was performed after the new transformer was energized. No other problems were encountered during this installation.

4.3 Building 378

The Building 378 installation consisted of removing three existing PCB transformers in three different locations (pads 378-1, 378-2, and 378-6);

replacing them with three new cast coil transformers in two locations; and consolidating power feeders.

The pad 378-1 installation is located in a vault and consisted of removing a 1000 kVA PCB transformer and two PCB-filled voltage regulators and replacing them with a 1000 kVA cast coil transformer and a 500 kVA transformer. The transformer that was removed had a 2400 V primary and a 208 V secondary. The primary voltage to the vault was upgraded to 12 kV by tapping into an existing pothead in pad 378-2. The new 1000 kVA cast coil transformer was constructed as a unit substation with a new 15 kV fused switch and 480/277 V secondary switchgear. The secondary of the new transformer was 480/277 V grounded wye. The 500 kVA cast coil transformer was installed in the vault to step down the output of the 1000 kVA unit from 480 to 208 V. The output of this second unit was connected to the existing 208 V switchgear.

The pad 378-2 installation consisted of removing a 500 kVA PCB transformer and feeding the panel from the new switchgear on the 1000 kVA transformer in vault 378-1. No new transformer was installed at pad 378-2. A local main disconnect breaker was retrofitted to the back of the existing load panel, and new supports had to be fabricated to support the load panel that was originally mounted directly to the PCB transformer. This load consolidation reduced the power losses, reduced the transformer cost, and provided environmentally safe and efficient power delivery.

The pad 378-6 installation consisted of a direct one-for-one replacement of a 500 kVA PCB transformer with a new 500 kVA cast coil transformer. The existing secondary switchgear and primary air interrupter switch were reused. The new transformer was physically larger than the original unit; thus, the concrete pad had to be extended. The size increase is common when liquid-filled transformers are retrofitted with dry-type transformers. During this installation it was noted that the insulation on the existing conductors connecting the primary switch to the transformer was in poor condition; therefore, the conductors were removed and new conductors were installed.

This installation required a great amount of planning. Very little work could be performed before the outage because of the space limitations in the facility. The doorway entering the vault was slightly smaller than the dimensions of the old transformer that was to be removed. Thus, the contractor needed to cut one of the termination throats from the transformer. A significant problem was encountered during this process. The contractor failed to clean the inside of the throat before using the cutting torch. The bushings inside the throat had leaked transformer fluid into the throat and the fluid contained PCBs. The material began to smoke immediately after heat was applied. The contractor was immediately stopped. The environmental waste handling crew then cleaned the throat with solvent to remove the PCBs. Once the throat had been cleaned, the PWC environmental office inspected the throat and gave the contractor permission to complete the cut, which was completed without further incident. The existing 2400 V feeder (three conductor lead sheathed cable) to the old transformer in vault 378-1 could not be removed and had to be capped and abandoned in placed. The contractor attempted to remove the cable and could not pull it. The San Diego PWC stated that the cable should be capped and abandoned in place.

4.4 Building 379

The Building 379 installation consisted of removing three existing 167 kVA PCB-filled, single phase, polemount transformers that were connected in a three phase bank and replacing them with a single 300 kVA Square D Company VPI dry-type transformer. This task also involved removing another PCB-filled transformer from the roof of Building 379. The loads, which were fed by this transformer, were then alternately fed using another existing transformer. Ultimately, four PCB transformers were removed from the facility and replaced with a single modern dry-type transformer. The Square D Company hired a local subcontractor (Chula Vista Electric) to perform the actual removal and installation.

The new 300 kVA transformer is uniquely constructed with a dual rated primary winding. The winding can be connected in a 2400 V or a 12000 V delta configuration. The new transformer was installed in the 2400 V configuration using the existing oil filled cutouts.

The original installation was very congested. The three 167 kVA transformers were packed into a very confined space on an overhead wooden mezzanine with little or no clearance for maintenance personnel. The new transformer was constructed to slip into the installation without having to modify the roof support structure. The new installation provides a clean transformer enclosure design and small size, allowing adequate clearance around the unit so maintenance can be performed on the unit. Installing this unit involved an intricate rigging configuration that had to be well planned. The installation went smoothly without incident.

4.5 Building 472

This installation is in a corrosive environment. The transformer and primary and secondary switchgear are located between two stack assemblies. The moisture and corrosives emanating from the stacks have caused extensive corrosion to the existing transformer enclosure and the existing primary and secondary switchgear. task involved removing the existing 1500 kVA PCB-filled transformer and replacing it with a new 1500 kVA cast coil ventilated dry-type transformer with future forced air provisions. Cast coil transformers are extremely resistant to corrosives and are environmentally inert; thus, the new transformer could be installed in the same location as the old unit. New code requirements require a substantially greater distance between the facility and a standard oil-filled transformer. A new mineral-oil filled transformer could not have been installed without performing substantial facility modifications. The high efficiency cast coil dry-type transformer was installed outside on the exiting pad without any facility modification. This installation was performed on November 3 and 4, 1990, by ABB Service Company and their subcontractors.

4.6 Building 473

The installation at this facility was delayed. The specification detailed the design requirements of the new transformer; however, the contractor manufactured the new extremely high efficiency amorphous core transformer with the wrong secondary voltage. A new transformer was manufactured and was installed on February 22, 1992. Building 473 was a prime candidate for an amorphous core transformer. The building was being served by a 112.5-kVA PCB liquid-filled transformer that was lightly loaded.

The transformer no-load loss (core loss) remains constant at all levels of transformer loading. The load loss, however, increases proportionally to the loading. Under lightly loaded conditions, the no-load loss comprises a more significant portion of the total losses of a transformer. Building 473 is only occasionally heavily used and typically has minimal loading. The extremely low no-load loss of the amorphous core transformer will reduce the power consumption at Building 473 considerably. No problems were noted during this final installation.

4.7 Building 489

The original 1500 kVA transformer feeding Building 489 failed and the replacement was added to this project. Following the failure, the failed unit was removed and a temporary 3750 kVA unit substation transformer was installed by the Navy PWC. This unit provided temporary power to the facility until this permanent replacement was installed. The existing 15 kV class primary switch had been damaged during the transformer failure but had to be rebuilt and placed back into service concurrent with installation of a new transformer.

This installation began with the removal of the 3750 kVA temporary transformer. The San Diego PWC removed the temporary 3750 kVA unit. A new 1500 kVA cast coil transformer was then installed by the ABB Service Company. The new unit has a 12000 V delta primary and a 480/277 V grounded wye secondary. The original 15 kV fused switch was rebuilt by the ABB Service Company and placed back into service with the new transformer. The ABB Service Company had not anticipated needing new fuses for the primary switch and had to obtain them before the new transformer could be energized. No other problems were identified during this installation.

5. TYPES OF TRANSFORMER CONSTRUCTION

Cast coil transformers provide an acceptable and preferable alternative to PCB transformers. They are self-extinguishing and, therefore, offer high levels of fire safety compared to liquid-filled transformers, they are efficient, and they perform exceptionally in the corrosive environments common to Navy installations.

Liquid-filled transformers have been used for severe duty applications for many years. High fire point insulating liquids allow the use of liquid-filled transformers in locations where there is a risk of fire. The most commonly used high fire point liquid is commonly referred to as Askarel and is primarily comprised of PCBs. Use of PCBs was outlawed in 1977 because of health problems, primarily caused from the by-products of combustion of these fluids such as furans and dioxins. Thus, alternative transformer types or fluids must be used.

The primary alternatives for PCB-filled transformer replacements are "less flammable" liquid-filled transformers (insulating liquids with a minimum fire point of 300°C are classified as "less flammable" by UL and Factory Mutual) and dry-type transformers. The first alternative, "less flammable" liquid insulated transformers, is a good alternative but will not work in all locations. For example, certain restrictions or requirements apply when installing liquid-filled transformers. There are several currently available "less flammable" transformer insulating liquids. They are typically high molecular weight hydrocarbons. The second alternative is to use dry-type transformers. "Less flammable" liquid-filled transformers are not an option where vault requirements or fire codes restrict their use.

There are two general dry-type transformers to evaluate: standard and CC. The standard dry-type transformers, open wound and VPI, are not designed to withstand the stress, use, and physical abuse of a comparable liquid-filled transformer. Issues such as temperature rise, basic impulse level, and short-circuit strength are common weaknesses of standard dry-type transformers when compared to liquid-filled transformers. However, cast coil dry-type transformers perform with ratings equal to or greater than those of comparable liquid-filled designs. The following characteristics of liquid-filled and cast coil dry-type transformers were compared:

- Basic impulse level
- Sound level
- Short time overload capability
- Weight
- Thermal rating (temperature rise capability)
- Load losses.

In all cases, cast coil transformers met or exceeded liquid-filled transformer parameters for these characteristics.

5.1 Cast Coil Transformers

Cast coil transformers are dry-type transformers with vacuum cast coil assemblies. The manufacturers of cast coil transformers use two basic methods of coil construction. One design uses fiberglass cloth to provide mechanical support along with a thin layer of epoxy encapsulation. The other design uses a thick layer of silica-filled epoxy to provide both the dielectric and mechanical strength.

Cast coil transformers are available with both copper and aluminum conductors. The aluminum units are somewhat less expensive to manufacture but typically are larger and less efficient. The design that uses the thin layer of epoxy requires that the coils must be cast in precision molds (i.e., they require high quality control). This requirement for precision molds depends directly on the design of the coils and adds significantly to the mold fabrication cost. The manufacturers that use precision molds are typically limited to building only the coils for which they have molds, and they typically cannot build custom units. This is a problem for loss evaluated units in which a larger amount of conductor is used in the coils to reduce the resistive losses. The manufacturers that use the thick epoxy have more flexibility because they can often afford to build a mold or use an existing mold for a custom transformer if needed.

These types of transformers are currently available with either copper or aluminum windings to sizes of approximately 10,000 kVA.

For additional information on cast coil transformers refer to EG&G reports EGG-2591, February 1990, Cast Coil Transformers Fire Susceptibility and Reliability Study, and EGG-EE-8652, August 1989, Cast Coil Transformer Summary Report Based on Experiences at Norfolk Naval Base.

5.2 Vacuum Pressure Impregnated/Encapsulated Transformers

Vacuum pressure impregnated/encapsulated (VPI/E) transformers are dry-type transformers with coils that are impregnated (or encapsulated) with a silicone, polyester, or epoxy resin while under vacuum. The resin is intended to provide a barrier against moisture, dust, and corrosives and increase overall coil insulation. The relatively thin resin coating does not provide added mechanical strength as does the CC. The vacuum pressure encapsulation process was specifically developed for the Navy to improve impregnation and moisture resistance of the windings. This enabled the Navy to use high voltage dry-type transformers aboard ships especially in the high moisture environment. These types of transformers are currently available with either copper or aluminum windings to sizes of approximately 10,000 kVA.

5.3 Liquid Filled/Amorphous Core Transformers

Liquid-filled amorphous core transformers are currently being produced in industry from 15 to 2500 kVA. These extremely efficient transformers have a significantly reduced magnetic loss characteristic. The only difference between the typical and amorphous core liquid-filled transformer is in the core construction.

Amorphous metals, developed and patented by Allied Corporation under the trade name of Metglas, are a new class of metallic materials. Unlike other metals or alloys of metals, amorphous metals do not have grain structure; they are more characteristic of glass. When normal metals or alloys cool from the molten state, the atoms arrange themselves into an orderly lattice of crystals. The intercrystalline boundaries play a major role in the hysteresis losses experienced by steel when subjected to the alternating current in a transformer. In the Metglas process, an alloy of iron, boron, and silicon is cooled at approximately 1 million °C/s. This rapid cooling causes the atoms to arrange themselves in a random fashion as they do in glass, rather than in the highly structured crystalline lattices found in metals. The end result of this process is a material that, used in the core of a transformer, cuts the no-load losses to about 25 to 40% of the losses of an equivalent silicon-steel core.

For more information on Amorphous Core Transformers refer to NCEL Report N-1801, August 1989, 25 kVA Amorphous Metal-Core Transformer Developmental Test Report, and EGG-EE-8748, June 1991, Retrofill/Retrofit Study of PCB Electrical Transformers U.S. Navy Public Works Center Pearl Harbor, Hawaii.

6. RECOMMENDATIONS AND CONCLUSIONS

The San Diego Advanced Transformer Evaluation and Validation Project was completed successfully. It would be useful to consider these recommendations for future transformer installation and operation:

- Provide on-line documentation and tracking for the replaced transformers. This information must be provided to the PWC, the fire department, and any other organizations who need it so that their records can be updated to show that the hazardous wastes (PCBs) have been mitigated.

  A previous incident at the Norfolk Naval Base involved a PCB transformer that had been replaced with a new transformer. The new unit caught on fire, and the fire department would not enter the vault to put the fire out because their records listed the unit at PCB filled. The damage to the unit and vault could have been reduced substantially if the proper records would have been updated.

- Install cast coil transformers in environmentally sensitive areas and areas with high power rates. They also are excellent for use in facilities that experience cyclical loads where the transformers are or can be shut down for long periods of time or when varying loads are experienced.

- Evaluate amorphous core transformers when life-cycle costs indicate that small increases in purchase price will be recovered by the reduced losses of the transformer.

- Conduct a follow-on study on the VPI transformer installed in Building 379. The operational data will provide the Navy with verification of the performance of a VPI transformer in a shore-based Navy application.

- Thoroughly investigate the replacement sites for access, floor space, and other interface requirements that could possibly cause problems during the installation. Any findings should be pointed out to the contractors before installation to minimize impact.

- Strictly monitor the installation schedule and coordination with the PWC. Ensure that all aspects are properly scheduled and that all needed resources and personnel are available.

- Strictly monitor the contractor to ensure that all areas are thoroughly cleaned after the installations are complete and that all materials and debris are removed from the job site.

The transformer installations illustrate technology evaluation, operational performance, fire code compliance, and sizing. These types of transformers each have their specific applications and advantages and serve as excellent replacements for PCB-filled/contaminated transformers in Navy applications. Each of the types of transformers demonstrated during this project will provide the Navy with environmentally safe and efficient power delivery alternatives to PCB-filled transformers.

Appendix A

Specifications

EG&G Idaho, Inc.
FORM EG&G-680

ES — 51333 Rev. B

DATE — May 4, 1990

SPECIFICATION

FOR

THE PURCHASE AND INSTALLATION OF LIQUID FILLED TRANSFORMERS
AT THE SAN DIEGO NAVAL FACILITY

PROJECT NO.

015341

Approved for Release:

M. L. Nelson
Engineering Graphics
EG&G Idaho, Inc.

EG&G Idaho Inc.

Form EG&G-1824
(Rev. 09-83)

DOCUMENT APPROVAL SIGNATURE SHEET

Type of Document	Document No.
ENGINEERING SPECIFICATION	ES-51333

Title
SPECIFICATION FOR THE PURCHASE AND INSTALLATION OF LIQUID FILLED TRANSFORMERS AT THE SAN DIEGO NAVAL FACILITY

Prepared By S. A. MCBRIDE   Ext. 9330

Originated By G.D. SEIFERT   Ext. 9522

(PRINT OR TYPE NAME IN SPACE ABOVE SIGNATURE)

Approval and Review Signatures	Organization	Mail Address	Date
J.F. JACOBSEN	INEL - POWER SYSTEMS ENGINEERING		11/20/89
V.E. JBERG VE Berg	INEL - Quality Engineering	3508	11-20-89
A.D. HILL	INEL - ELECTRICAL SAFETY	3423	11-20-89
R.J. WHITE	NCEL- EE PROGRAM MANAGER	2302	11/20/89
Revision A per DRR EGB-736 Released by Engineering Graphics on 3-26-90 M L Nelson			
Revision B per DRR EGB-753 Released by Engineering Graphics on 5-4-90 M L Nelson			
	A-4		

CONTENTS

APPENDICES

ES-51333

SPECIFICATION
FOR THE PURCHASE AND INSTALLATION OF
LIQUID FILLED TRANSFORMERS AT THE
SAN DIEGO NAVAL FACILITY

1. SCOPE

1.1 Scope. This specification covers the design, fabrication, testing, installation, and inspection of new liquid filled, power transformers and the removal of the existing polychlorinated biphenyl (PCB) filled transformers, handling of PCB fluid, and obtaining the permits required for hauling hazardous waste. The intent is to make a turnkey replacement with advanced technology transformers including any equipment needed to replace the existing transformers. They will be used to provide the Navy with performance data on these advanced technology devices.

1.2 Applicability. It is not the intent to specify details of design and construction except where necessary to establish performance requirements, nor is it intended to set forth those performance requirements, which are adequately specified in applicable standards.

All components of the transformers shall function in a satisfactory manner within their rated capacity under the specified service conditions regardless of whether all necessary specific performance requirements are set forth herein or in applicable standards.

2. APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent specified herein. The issue of a document and amendments in effect on the date of publication of this specification shall apply.

2.1 American National Standard Institute (ANSI).

ANSI-C57 12.00	General Requirements for Liquid Immersed Distribution Power and Regulating Transformers
ANSI-C57 12.13	Requirements for Conformance Liquid Filled Transformers Used in Unit Installation including Unit Substations
ANSI-C57 12.27	Conformed Requirements for Liquid Filled Transformers Distribution Used in Pad Mounted Installation, including Unit Substations
ANSI-C57 12.80	Terminology for Power and Distribution Transformers
ANSI-C57 12.90	Test Code for Liquid Immersed Distribution, Power, and Regulating Transformers
ANSI-C57 12.91	Test Code for Dry Type Distribution and Power Transformers
C2-1989	National Electrical Safety Code
ANSI-C57-13	Requirements for Instrument Transformers
Z35.1	Specifications for Accident Prevention Signs

2.2 American Society of Testing and Materials (ASTM).

ASTM D 92-78	Flash and Fire Points by Cleveland Open Cup
ASTM D-877	Dielectric Breakdown Voltage of Insulating Liquids
ASTM D-923	Sampling Electrical Insulating Liquids

ASTM D-924	Power Factor and Dielectric Constant
ASTM D-974	Neutralization Number
ASTM D-1533	Water in Insulating Liquid
ASTM D-2225	Methods of Testing Silicone Fluids Used for Electrical Insulation
ASTM D-3487	Mineral Insulating Oil Used in Electrical Apparatus
ASTM D-4652	Standard Specification for Silicone Fluid Used for Electrical Insulation

2.3 National Electric Manufacturers Association (NEMA).

NEMA TRI-1974	Transformers, Regulators, and Reactors

2.4 National Fire Protection Association (NFPA) Publication.

NFPA 70	National Electrical Code

2.5 Others.

IEEE 400-1980	IEEE Guide for Making High Direct Voltage Tests on Power Cable Systems in the Field
NEESA 20.2-028a	PCB Compliance, Assessment, and Spill Control Guide
OPNAVINST 5090.1	Environmental and Natural Resources Protection Manual
29 CFR	General Industry Safety and Health Standards

40 CFR 263	Standards Applicable to Transporters of Hazardous Waste
40 CFR 172	Hazardous Materials Tables and Communications Standards
49 CFR 173	General Requirements for Shipping and Packaging
40 CFR 761	Polychlorinated Biphenyls (1979)
PWC San Diego	Utility Standards
California CAC Title 22, *Division 4*	*Environmental Health*
MIL-P-28641	Primer Coating, Vinyl Chlorine Acetate, Copolymer, High Build (for steel and masonry)
MIL-Q-9858A	Quality Program Requirements

3. TECHNICAL REQUIREMENTS

3.1 General. *The transformers shall have low loss metal core and shall* be three phase, three-winding, fluid-immersed, self-cooled, dead front, suitable for installation indoors or outdoors, or as specified in the individual data sheets in Appendix A. They shall have primary and secondary compartments that shall enclose all termination devices so that no live parts are exposed when the transformer is energized. Unit substation transformer installations are exempt from the dead front requirement. The transformer and installation shall meet all applicable requirements of the ANSI, ASTM, NEC, and NEMA publications as specified herein. The transformer shall be of new construction. The successful bidder shall be responsible for all field modifications and measurements and provide installation and checkout, and turn the transformer over to the operations department, PWC San Diego, through the EG&G Idaho, Inc. Resident Engineer ready for operation. A

3.2 Electrical Products. All materials, appliances, equipment, or devices shall be new and conform to the applicable standards of the Underwriter's Laboratories, Inc. (UL) and applicable chapters of the National Electrical Code (NFPA 70), where such standards exist. All materials, appliances, equipment, or devices shall be listed and/or labeled by UL, where such standards exist.

3.3 Condition of Products. Except as otherwise indicated, new electrical products free of defects and harmful deterioration shall be provided at the time of installation. Each product provided shall be complete with trim, accessories, finish guards, safety devices, and similar components specified or recognized as integral parts of the product, or required by the governing regulations.

3.4 Uniformity. Where multiple units of a product are required for the electrical work, identical products shall be provided by the same certified and approved manufacturer without variations except for sizes and specific variations as indicated.

3.5 Test Point Observation. The successful bidder shall supply EG&G Idaho with a flow sheet for the manufacture of each transformer indicating all test points. The successful bidder shall notify EG&G Idaho, in writing, of the date that each test will be conducted at least 14 days before that test and will admit EG&G Idaho and government representatives to witness the tests.

3.6 Performance Requirements. Each transformer shall comply with the following performance requirements as specified in ANSI-C57 12.00, except as noted in the data sheets in Appendix A.

Transformer Rating	As specified in Appendix A.
Auxiliary Cooling	Forced air provisions, fan mounts, and temperature sensor access points as a minimum shall be provided for future. Refer to the data sheets in Appendix A for special instructions.

Primary Voltage	As specified in Appendix A. Note special dual voltage requirements.
Primary Connection	As specified in Appendix A.
Frequency and Phase	60 Hertz, 3 Phase
Secondary Voltage	As specified in Appendix A.
Secondary Connection	Wye connection with neutral to be brought out through an insulated bushing with external ground strap.
Insulating Liquid	The insulating liquid shall be "less flammable" as defined in the NFPA with 284°C minimum flashpoint and 312°C minimum firepoint and shall have less than 30 ppm water content per ASTM D-4625. The liquid shall be as specified in the data sheets; however, evaluated options of alternatives will be considered if they are to the best advantage of the U.S. Government.

Silicone liquid with 300°C minimum flashpoint and 340°C minimum firepoint and shall have less than 30 ppm water content per ASTM D-4652. Askarel and insulating liquids containing PCBs shall not be provided.

or

The insulating liquid shall be RTEMP with 284°C minimum flashpoint and 312°C minimum firepoint and shall have less than 5 ppm water content.

Insulating Paper	There shall be less than 1% moisture by dry weight in the paper insulation.
Temperature Rise	55°C per NEMA TRI-1974.
Taps - No Load	Minimum of five full capacity high voltage taps (two 2-1/2% taps above and two 2 1/2% taps below normal voltage and tap position indicators).
Insulation Levels	
Primary Voltage	95 KV BIL for Insulation Class 15 KV and 75 KV BIL for Insulation Class 5 KV. Based on specific voltage ratings, which are in the data sheets in Appendix A.
Secondary Voltage	30 KV BIL for Insulation Class 600 V. For specific voltage ratings, see the data sheets in Appendix A.
Core Material (General)	The core shall be constructed of low loss silicon steel sheets except where specified as amorphous. The specific type of low loss silicon steel is to be determined by the manufacturer to meet the lowest total operating costs and optimize no-load losses. However, the intent of this replacement program is to install advanced technology transformers wherever it is economically feasible. The use of amorphous metal, laser etched steel, or other advanced technology core material is encouraged in order to meet low operating cost criteria.

Core Material (Amorphous)	The following applies to those transformers specified as amorphous core. The transformer shall be constructed of low loss amorphous metal. The complete core assembly shall be fully encapsulated with a protective coating of approved material to eliminate sharp edges and prevent flaking particles from entering the coolant during normal operation. The no-load losses shall be less than 45% of those no-load losses of comparable silicon steel core designs. It is known that a wound core is standard. However, a few of the options in the data sheet specifically require stacked core. This stacked core will be treated as a research project to get a "new" technology unit. The other amorphous core device can be wound (or stacked) at the manufacturer's discretion.
Impedance	As specified in the data sheets in appendix A with the following guidelines: 1. The minimum allowable impedance for transformers 750 KVA and above is 4.0 percent. 2. The minimum allowable impedance for transformers 500 KVA is 3.5 percent. 3. The tolerance is +/- 7 1/2 % except for the transformers with dual rated primaries which shall have an impedance tolerance of +/- 10 %
No-Load Loss	The no-load losses (core losses) shall be optimized per the evaluation formula provided in the bid package/Request For Proposal (RFP).

Load Loss	The load losses (winding losses) shall be optimized per the loss evaluation formula provided in the bid package/RFP.
Sound Level	Shall not exceed noise level per NEMA standards.

3.7 Environmental Conditions.

Elevati	50 feet above sea level
Location	Indoor/outdoor (See Appendix A.)
Temperature Range	0°C to 40°C

3.8 Accessories. The transformer shall have the following accessories as a minimum. The accessories shall be constructed and located as described in ANSI-C57 12.00.

- Elbow terminators, fuses, load break switches, and tap changers as called out in Section 3.6, primary connection section, and per individual data sheets in Appendix A.
- Magnetic liquid level gauge with 25°C level marking.
- Dial type thermometer with alarm contact of sufficient capacity to control the future fan contactor and an additional contact for a future utility control system.
- Pressure - both a vacuum bleeder device and a high volume pressure relief device rated at a minimum of 100 SCFM at 15 psi. Additional pressure relief capacity will be required and installed per UL classification, if RTEMP fluid is used.

- 1 inch NPT boss and plug in tank top situated such that a 1/2 inch fiberglass instrument rod could be inserted (in the future by others) into the fluid (straight down) without contacting any part of the bus or core assembly.

- Upper Filler Connection - 1 inch nipple with plug.

- Drain Valve - 1 inch globe valve.

- Lower Sampling Valve - min. 3/8 inch at tank bottom (may be part of drain valve assembly).

- Upper Sampling Port - min. 3/8 inch boss in tank wall and valve (with cap) approximately 1 inch below top fluid level to allow future diagnostic instrumentation access (by others).

- Lifting, moving, and jacking provisions.

- Stainless steel/aluminum nameplate with information required in ANSI-C57 12.00 at two locations: one on the transformer exterior and one in the secondary cubicle. (note: stainless steel is preferred) A

- A junction box shall be located on the transformer nameplate side and contain a terminal board for all electrical circuits entering or leaving the junction box. The junction box shall have a hinged door with a gasket and a handle with provisions for padlocking. All electrical circuits from components mounted within the transformer shall run to this terminal board.

- An optional top oil temperature sensing thermocouple shall be mounted in the prevailing transformer top oil thermal hot spot. As a minimum, the thermal well housing must be included, even if the optional top oil temperature sensing thermocouple is not added. The thermocouple shall be A installed in a thermal well housing that will allow maintenance. This thermocouple will provide input to an electronic temperature monitor. This instrument shall respond to the top oil temperature and automatically display this reading. An analog meter shall continuously display the top oil temperature and indicate the maximum temperature reached over a period of time. Light emitting diodes are not acceptable. The highest temperature shall also be used to initiate alarm and trip functions and is stored for future recall until the maximum temperature memory is cleared. Fail safe alarm relay circuits automatically actuate if supply power has been lost. Maximum temperature can be recalled even if supply power has been interrupted. A self-test procedure allows set points to be determined and their operation verified. Alarm and trip set points will be tested from the front panel. Open thermocouple circuits are detected and indicated, but do not affect instrument operation. Manual control of alarm and test functions shall be provided. All input and output connections shall be made to the terminal blocks on the back of the instrument. The set points of this thermal device shall be adjustable, and two sets of alarm and trip contacts shall be provided. The alarm contacts on the temperature indicator shall be factory wired and brought out to terminal blocks on the exterior of the transformer enclosure. The terminal blocks shall be mounted in the junction box. A thermometer with a remote sensing bulb is not acceptable. The thermocouple shall be removable without disconnecting the electrical wiring. The temperature monitor system shall be graduated in degrees centigrade and shall be tested at 200°C before installing on the transformer. The thermally operated device shall be coordinated with the transformer design and shall be connected and set to function as follows:

- First stage shall be adjustable and set at 75°C temperature at which the substation audible bell alarm can be activated (connected in future by others).

- Second stage shall be adjustable and set at 100°C temperature at which the transformer is isolated by removing the electric load and tripping all the power circuit breakers via the circuit breakers' shunt trip coils (connected in future by others).

3.9 Tank Construction. The tank shall be of welded steel construction designed to withstand a pressure 25% greater than the maximum operating pressure and normal working vacuum. The cover shall be provided with access holes or manholes, lifting eyes, and pressure relief. The base shall permit rolling or skidding with pulling eyes and be equipped with ground pad.

3.10 Paint. The color of the finished transformer shall be C37.20 Federal Standard 595 dark forest green enamel.

3.11 Miscellaneous Requirements.

3.11.1 Insulated Phase Barriers. Primary and secondary insulated phase barriers shall be provided.

3.11.2 Undercoating. Transformers, which have bases that come in contact with concrete, shall have the underside of their bases coated with a corrosion resistant coating that conforms to Military Specification MIL-P-28641 (or an equivalent) with a minimum thickness of 4 mils.

3.11.3 Warning Signs. In accordance with ANSI Z35.1, warning signs shall be provided for the enclosures of electrical transformers having a nominal voltage rating of 500 volts or above.

3.12 Provisions for Fan Cooling. The transformer, 500 KVA and larger, shall have provisions for future fan cooling (by others). As a minimum, fan mounting brackets and dial thermometers with control contacts shall be provided.

3.13 Testing. The following tests shall be performed in accordance with NEMA TRI, ANSI-C57 12.90, and ASTM Standards as listed by the associated tests. All testing, except the field tests, shall be done at the factory, and the certified results shall be submitted to the buyer for approval before shipment of the transformer. Field tests shall be performed unless specifically denied by EG&G Idaho and shall also have certified test procedures and results if opted by EG&G Idaho. All testing included in this Specification shall be performed and costs must be included in the transformer purchase price. A

The purchaser reserves the right to witness any or all tests, and the vendor shall notify the purchaser 14 days in advance of the date for conducting any test (see Section 3.5).

Field tests shall be conducted by representatives of the manufacturer and shall be completed after the transformer has been set in place and before the primary and secondary connections are made. These tests shall be as described in Section 3.13.3.

The tests below shall be made on the transformer as a minimum requirement. The order of listing does r t necessarily indicate the sequence in which the tests shall be conducted.

3.13.1 Coolant Tests.

ASTM D-877	Dielectric Breakdown Voltage
ASTM D-923	Sampling Electrical Insulating Liquids
ASTM D-924	Power Factor
ASTM D-974	Neutralization Number
ASTM D-1533	Water in Insulating Liquid (field test only)
ASTM D-2225	Silicone Fluids if Silicone.

PCB contamination certification requires stating either that PCB content is less than 5 ppm or that the transformer is PCB free and contains no PCB. A stainless steel label clearly stating the PCB content shall be attached to the transformer.

3.13.2 Factory Electric Tests.

1. Coil resistance measurements of all windings on the rated voltage connection and at the tap extremes.

2. Turns ratio test on the rated voltage connection.

3. Polarity and phase relation tests on the rated voltage connection.

4. No-load loss at rated secondary voltage on the secondary voltage connection (field and factory test).

5. Exciting current at rated voltage on the rated voltage connection.

6. Impedance and load loss at rated current on the rated voltage connection and on tap extremes.

7. Temperature tests under conditions specified in ANSI Standards for transformers. (Typical temperature rise of the "exact" design may be substituted with written approval.)

8. Applied potential test.

9. Induced potential test.

10. Impulse test.

11. Insulation power factor.

3.13.3 Field Tests. Field tests shall be performed as part of installation. Test reports shall be certified for methodology and accuracy.

- No-load loss as measured from the secondary winding at ambient temperature (ANSI-C57 12.90). Record both ambient and top oil temperatures. Conduct this test on both existing transformers to be removed and the new transformers. Record ambient temperature on the test reports.

- Water content in oil at ambient temperature (ASTM D-1533). Record both ambient and top oil temperatures.

- Insulation power factor (Method II ANSI-C57 12.90, Section 10.9) Doble Test or equal. (Insulation power factor to be 0.9 or less.)

- Before energizing the transformer, test the transformer turn ratio (TTR) at all tap settings. Megger all leads before connecting them to the transformer and check the leads for grounds using VOM before any connections are made. Any lead with a Megger reading of less than 10 megohms shall be replaced.

4. QUALITY ASSURANCE PROVISIONS

Unless otherwise specified, the supplier is responsible for all examinations and inspections as specified herein. The vendor shall maintain a Quality Assurance Program in accordance with MIL-Q-9858A or an approved equal during the performance of the contract, which provides adequate quality assurance and control throughout design, fabrication, testing, inspection, and shipping of the transformer. The vendor shall provide the documents describing the Quality Assurance Program and containing the procedure that will be invoked to comply with the above. An Inspection and Test Procedure shall be prepared and submitted to the buyer for approval. Final inspection and test reports as required by this Specification shall be submitted to the buyer for approval. The vendor shall maintain a calibration system for the periodic calibration of test instruments to standards traceable to the National Bureau of Standards.

Vendor data shall be submitted per attached "Vendor Data Requirements Lists" (see Appendix B).

5. PACKAGING

The transformer shall be prepared for shipment within the Continental United States. All accessories shall be protected from damage. The transformer shall be sealed to prevent entry of moisture or foreign materials during shipment. Documents as indicated in Appendix B shall be required. Shipping is the responsibility of the supplier as part of the total installation package.

6. SUBMITTALS

Within 30 days of receipt of the order, the vendor shall furnish the purchaser with all necessary outline drawings and weights of the transformers.

6.1 Shop Drawings and Manufacturer's Data. Shop drawings for transformers shall indicate, but shall not be limited to, the following:

Overall dimensions, front view, interfaces with existing equipment, and sectional views.

Ratings and sizes of lugs, impedance, taps, and fans if applicable.

Manufacturer's published information on the main secondary breaker and feeder devices at each transformer to allow owner to review settings, which will ensure that proper protection and coordination will be achieved.

Complete list of spare parts and/or supplies with current unit prices and source of supply.

6.2 Certified Laboratory Test Data. Certified copies of reports of all tests shall be submitted as required.

6.2.1 Transformer Tests. Transformer test shall be performed in accordance with the ANSI-C57 12.90 - for liquid filled (ANSI-C57 12.91 - for dry-type) standard test code and Section 3.13. Certified copies of test data for the following tests shall be submitted and shall receive approval before delivery of equipment to the project site. Field test data sheets shall be submitted within 14 days after test completion.

7. DEMOLITION AND CONSTRUCTION

7.1 Demolition and Construction General Requirements. The vendor shall furnish technical personnel to be present at the site to perform, as a minimum, the following tasks (see Appendix C). Permits for PCB fluid and transformer casing transport shall be obtained by the successful bidder before removal. Note that OSHA regulations require workers handling PCBs to be properly trained and certified.

Request and have operating Contractor (PWC personnel) de-energize the existing transformers.

Test the existing transformers for no-load loss, record data, and submit in writing to the Resident Engineer.

Drain the PCB fluid from each transformer into approved drums, seal, and deliver it to the interim hazardous waste storage area at the base.

Purge the transformer case with dry nitrogen gas and seal.

Remove and deliver the transformers to the interim hazardous waste storage area at the base, as designated by the Resident Engineer.

Provide and install new transformers and test per Section 3.13.3.

Request PWC personnel to energize the system.

Verify proper operation and turn the operating transformer over to EG&G Idaho for remanding to PWC San Diego.

The EG&G Idaho Resident Engineer shall coordinate all outages and provide interface between the successful bidder's, installers, and the operating Contractor (PWC). PWC Code 640 is responsible for manifesting all PCB (hazardous waste) activity, and PWC shall be contacted through the EG&G Idaho Resident Engineer.

7.2 Draining. Service shall include removal, packaging, and transporting [to a Defense Reutilization and Maintenance organization (DRMO) hazardous waste staging area] of the PCB or PCB contaminated fluid initially drained from the transformers. DRMO waste shall be clearly labeled with contents, level of contamination, its source, and manifested by PWC Code 640.

The Subcontractor must review and comply with the minimum Outline Spill Prevention, Control, and Countermeasures (SPCC) Plan before draining fluid from a liquid cooled transformer (see Appendix D). Appendix D details the SPCC requirements that the Subcontractor must observe.

7.3 Transportation and Disposal. All hazardous waste material shall, as a minimum, be contained in Department of Transportation (DOT) approved containers from point of removal until delivered to the final disposal site. The following are methods of handling the wastes and are subject to the requirements of 40 CFR, Part 263 and 49 CFR, Parts 172 and 173 and shall be superseded if the regulations are amended.

1. Drums shall be DOT approved for hazardous waste: 17E for fluids, 17H for porous solids, and 17H for rags and solvent.

2. Bulk containers shall be six sided, welded steel construction, lined with a minimum of 10 mil plastic sheet, and watertight. The container shall be handled by a truck specially fitted to transport the container from generation point to disposal point.

APPENDIX A

TRANSFORMER DATA SHEETS

TRANSFORMER DATA SHEET

Transformer Identification	(PWC69-OLD) CC69-NEW *
Location	BLDG 94 OUTDOORS
Size	750/1000 KVA **
Primary Voltage	2.4/12 KV DUAL ***
Primary Winding Type	DELTA
Secondary Voltage	480 V
Secondary Winding Type	WYE-GROUNDED
Percent Impedance	5 %
Primary Switch	NEW 3 POLE 15 KV 600 AF/300 AT FUSED SWITCH
Primary Connection	PROVIDE TRANSITION CUBICLE TO NEW SWITCH
Secondary Connections	PROVIDE NEW COPPER BUS CONNECTIONS TO NEW SECONDARY SWITCHGEAR. PROVIDE AND INSTALL NEW SECONDARY SWITCHGEAR PER SKETCHES. (SEE APPENDIX E OF THIS DOCUMENT.)
Secondary Breaker	PROVIDE AND INSTALL NEW SWITCHGEAR PER ATTACHED SKETCHES
Maximum No-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP
Maximum Full-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP

* This is a replacement of transformer PWC #69, an existing 500 KVA 3 phase 480 V PCB transformer.

** Supply fan to achieve higher rating.

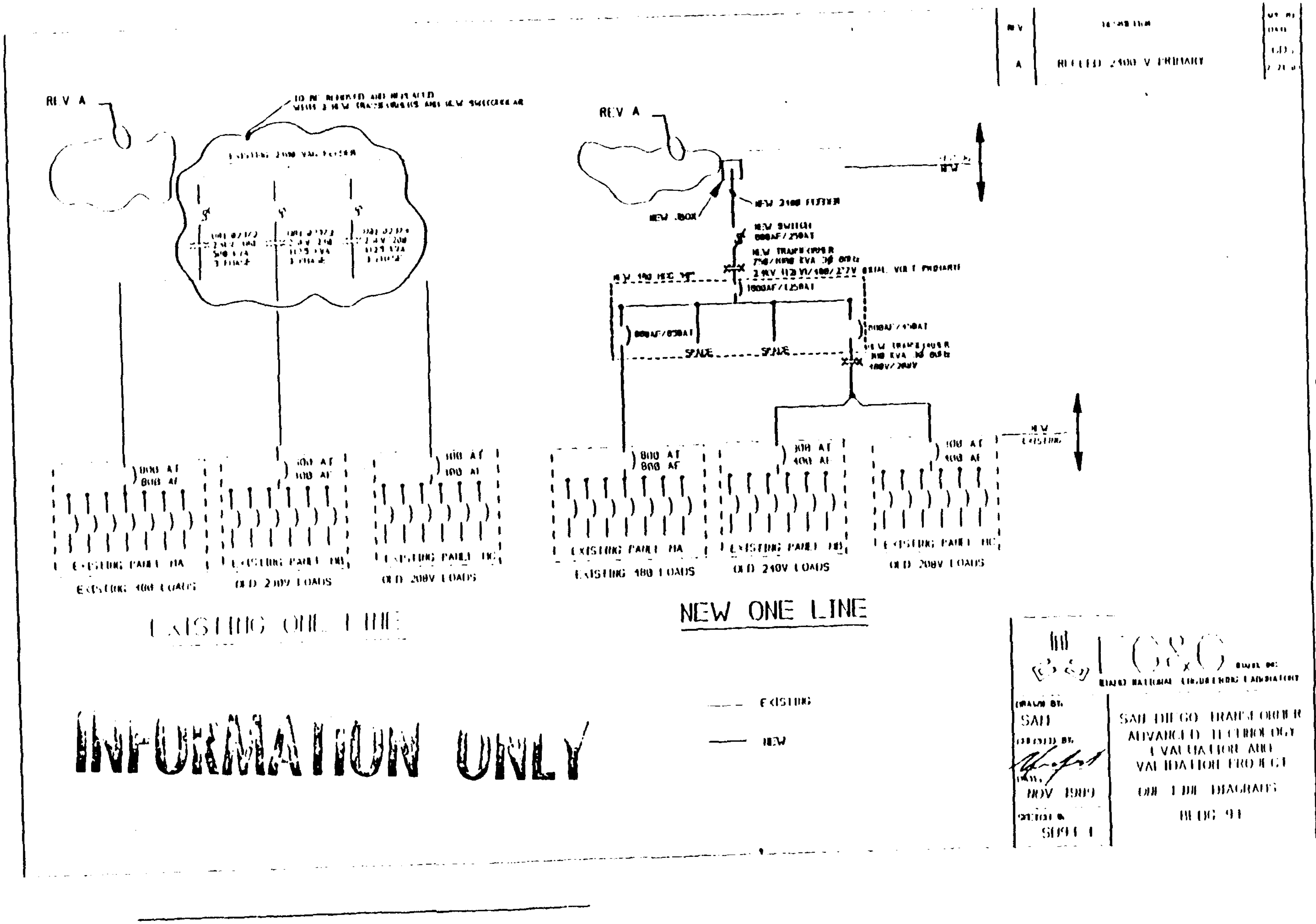
*** Dual voltage primary winding is an option. Regardless of whether the option is exercised, the 2400 VAC primary must be supplied. If the option is exercised then taps shall be provided for the higher rating (12 KV).

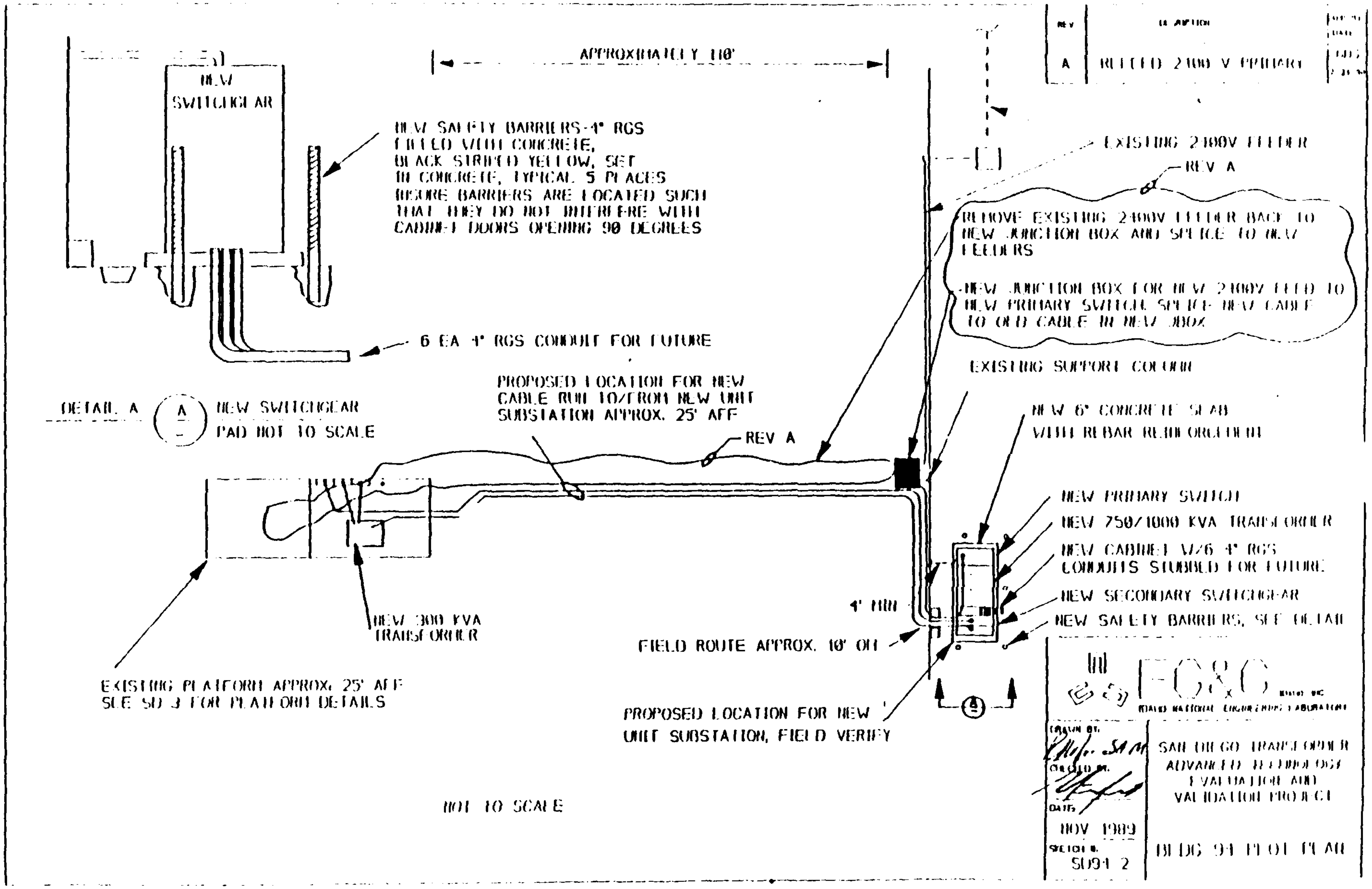
ES-51333

TRANSFORMER DATA SHEET

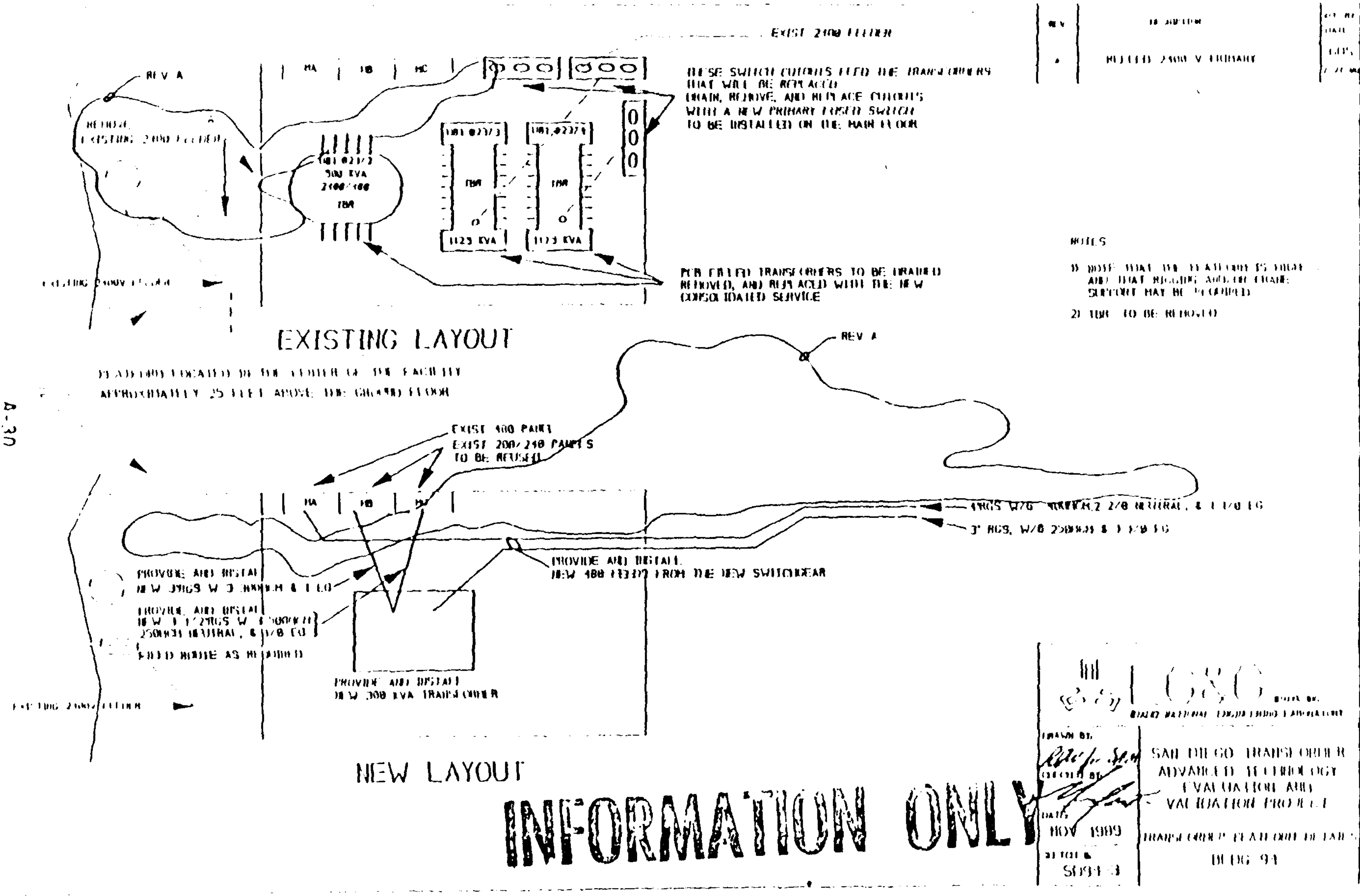
Transformer Identification	(PWC70-OLD) CC70-NEW *
Location	BLDG 94
Size	300 KVA
Primary Voltage	480 V
Primary Winding Type	DELTA
Secondary Voltage	208/120 V
Secondary Winding Type	WYE-GROUNDED
Percent Impedance	3.0
Primary Switch	N/A
Primary Connection	NEW FEED FROM NEW SWITCHGEAR (SEE CC69)
Secondary Connections	NEW CABLE AND CONDUIT CONNECTIONS TO EXISTING SWITCHGEAR (2 places)
Secondary Breaker	EXISTING BREAKER PER ATTACHED SKETCH
Maximum No-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP
Maximum Full-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP

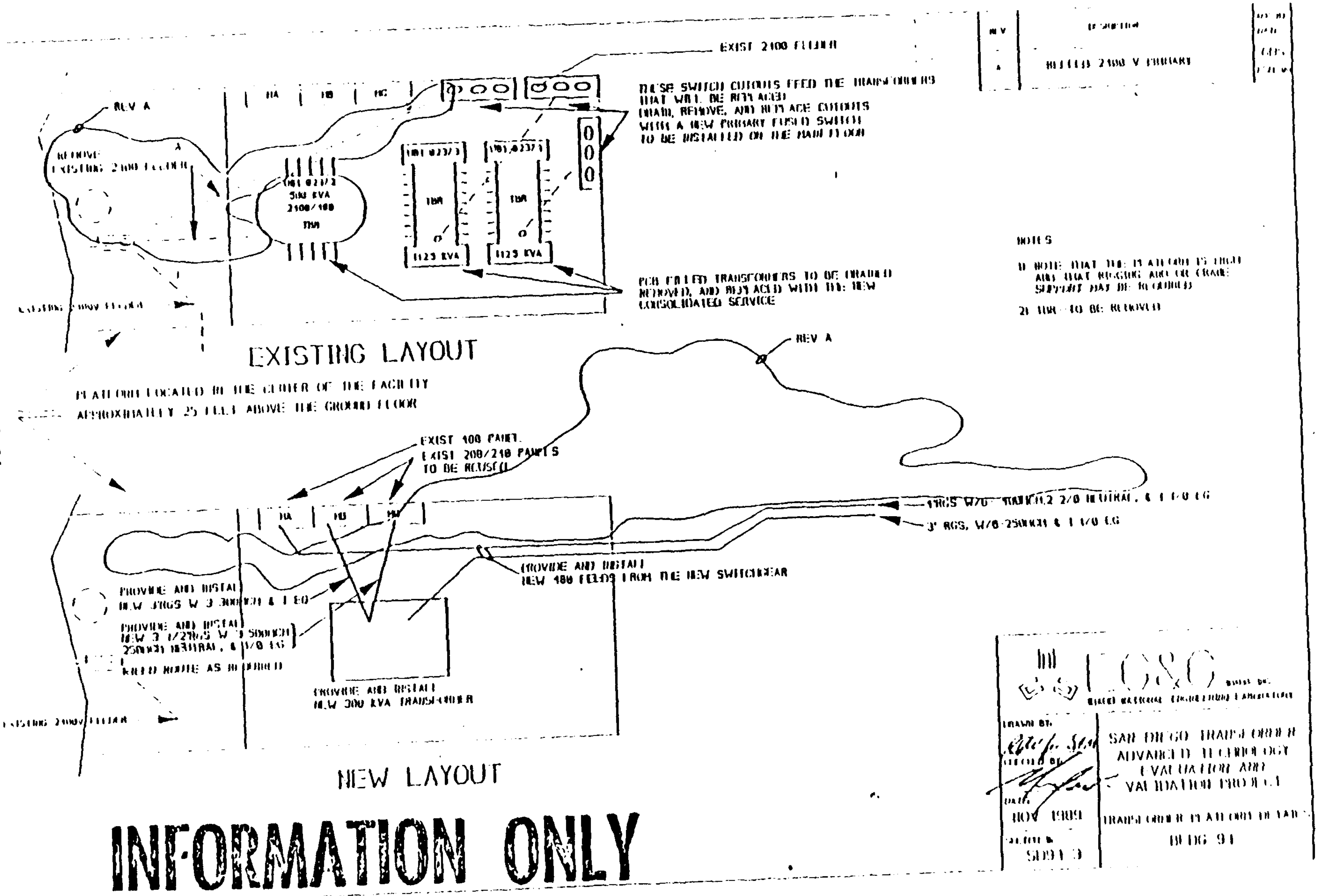
* Consolidation replacement of existing PCB transformers (#70 and #71). See sketches SD 1, 2, and 3 for additional information.


REV A
RECEIVED 2400 V PRIMARY
REV A
EXISTING 2400 VAC FEEDER
800 AF
800 AF
100 AT
100 AF
100 AT
100 AF
EXISTING PANEL HA
EXISTING 480 LOADS
EXISTING PANEL HB
OLD 240V LOADS
EXISTING PANEL HC
OLD 208V LOADS
EXISTING ONE LINE
REV A
NEW JBOX
NEW 2400 FEEDER
NEW SWITCH
800AF/250AT
NEW TRANSFORMER
1000AF/1250AT
800AF/850AT
SPACE
SPACE
800 AT
800 AF
300 AT
400 AF
100 AT
100 AF
EXISTING PANEL HA
EXISTING 480 LOADS
EXISTING PANEL HB
OLD 240V LOADS
EXISTING PANEL HC
OLD 208V LOADS
NEW ONE LINE
EXISTING
NEW
INFORMATION ONLY
DRAWN BY
SAN
DATE
NOV 1989
SHEET 1
SAN DIEGO TRANSFORMER
ADVANCED TECHNOLOGY
EVALUATION AND
VALIDATION PROJECT
ONE LINE DIAGRAMS
BLDG 91
A



APPROXIMATELY 110'
NEW SWITCHGEAR
NEW SAFETY BARRIERS-4" RGS FILLED WITH CONCRETE, BLACK STRIPED YELLOW, SET IN CONCRETE, TYPICAL 5 PLACES
INSURE BARRIERS ARE LOCATED SUCH THAT THEY DO NOT INTERFERE WITH CABINET DOORS OPENING 90 DEGREES
6 EA 4" RGS CONDUIT FOR FUTURE
DETAIL A
A
NEW SWITCHGEAR PAD NOT TO SCALE
PROPOSED LOCATION FOR NEW CABLE RUN TO/FROM NEW UNIT SUBSTATION APPROX. 25' AFF
REV A
NEW 300 KVA TRANSFORMER
EXISTING PLATFORM APPROX. 25' AFF SEE SD 3 FOR PLATFORM DETAILS
NOT TO SCALE
EXISTING 2400V FEEDER
REV A
REMOVE EXISTING 2400V FEEDER BACK TO NEW JUNCTION BOX AND SPLICE TO NEW FEEDERS
NEW JUNCTION BOX FOR NEW 2400V FEED TO NEW PRIMARY SWITCH. SPLICE NEW CABLE TO OLD CABLE IN NEW JBOX
EXISTING SUPPORT COLUMN
NEW 6" CONCRETE SLAB WITH REBAR REINFORCEMENT
NEW PRIMARY SWITCH
NEW 750/1000 KVA TRANSFORMER
NEW CABINET W/6 4" RGS CONDUITS STUBBED FOR FUTURE
NEW SECONDARY SWITCHGEAR
NEW SAFETY BARRIERS, SEE DETAIL
4' MIN
FIELD ROUTE APPROX. 10' OH
PROPOSED LOCATION FOR NEW UNIT SUBSTATION, FIELD VERIFY
A
REV
DESCRIPTION
A
REFEED 2400 V PRIMARY
EG&G
IDAHO NATIONAL ENGINEERING LABORATORY
DRAWN BY
CHECKED BY
DATE
NOV 1989
SKETCH NO.
SD91 2
SAN DIEGO TRANSFORMER ADVANCED TECHNOLOGY EVALUATION AND VALIDATION PROJECT
BLDG 91 PLOT PLAN


EXIST 2400 FEEDER
REV A
REMOVE EXISTING 2400 FEEDER
THESE SWITCH CUTOUTS FEED THE TRANSFORMERS THAT WILL BE REPLACED
DRAIN, REMOVE, AND REPLACE CUTOUTS
WITH A NEW PRIMARY FUSED SWITCH
TO BE INSTALLED ON THE MAIN FLOOR
500 KVA
TBR
1123 KVA
PCB FILLED TRANSFORMERS TO BE DRAINED
REMOVED, AND REPLACED WITH THE NEW
CONSOLIDATED SERVICE
EXISTING LAYOUT
APPROXIMATELY 25 FEET ABOVE THE GROUND FLOOR
EXIST 480 PANEL
EXIST 208/240 PANELS
TO BE REUSED
PROVIDE AND INSTALL
NEW 480 FEEDER FROM THE NEW SWITCHGEAR
3" RGS, W/0 250MCM & 1 1/0 EG
FEED ROUTE AS REQUIRED
PROVIDE AND INSTALL
NEW 300 KVA TRANSFORMER
NEW LAYOUT
NOTES
2) TBR - TO BE REMOVED
REV
A
DRAWN BY
CHECKED BY
DATE
NOV 1989
SAN DIEGO TRANSFORMER
ADVANCED TECHNOLOGY
EVALUATION AND
VALIDATION PROJECT
BLDG 94
INFORMATION ONLY


EXIST 2100 FEEDER
THESE SWITCH CUTOUTS FEED THE TRANSFORMERS THAT WILL BE REPLACED
REMOVE, AND REPLACE CUTOUTS WITH A NEW PRIMARY FUSED SWITCH TO BE INSTALLED ON THE MAIN FLOOR
REV A
REMOVE EXISTING 2100 FEEDER
500 KVA
2100/480
1125 KVA
1125 KVA
PCB FILLED TRANSFORMERS TO BE DRAINED, REMOVED, AND REPLACED WITH THE NEW CONSOLIDATED SERVICE
EXISTING LAYOUT
PLATFORM LOCATED IN THE CENTER OF THE FACILITY APPROXIMATELY 25 FEET ABOVE THE GROUND FLOOR
NOTES
1) NOTE THAT THE PLATFORM IS HIGH AND THAT RIGGING AND OR CRANE SUPPORT MAY BE REQUIRED
2) TBR - TO BE REMOVED
REV A
EXIST 100 PANEL
EXIST 200/210 PANELS TO BE REUSED
3" RGS, W/0 250MCM & 1 1/0 EG
PROVIDE AND INSTALL NEW 480 FEEDS FROM THE NEW SWITCHGEAR
PROVIDE AND INSTALL
PROVIDE AND INSTALL NEW 300 KVA TRANSFORMER
EXISTING 2400V FEEDER
NEW LAYOUT
INFORMATION ONLY
REFEED 2400 V PRIMARY
SAN DIEGO TRANSFORMER ADVANCED TECHNOLOGY EVALUATION AND VALIDATION PROJECT
NOV 1989
BLDG 91

ES-51333

TRANSFORMER DATA SHEET

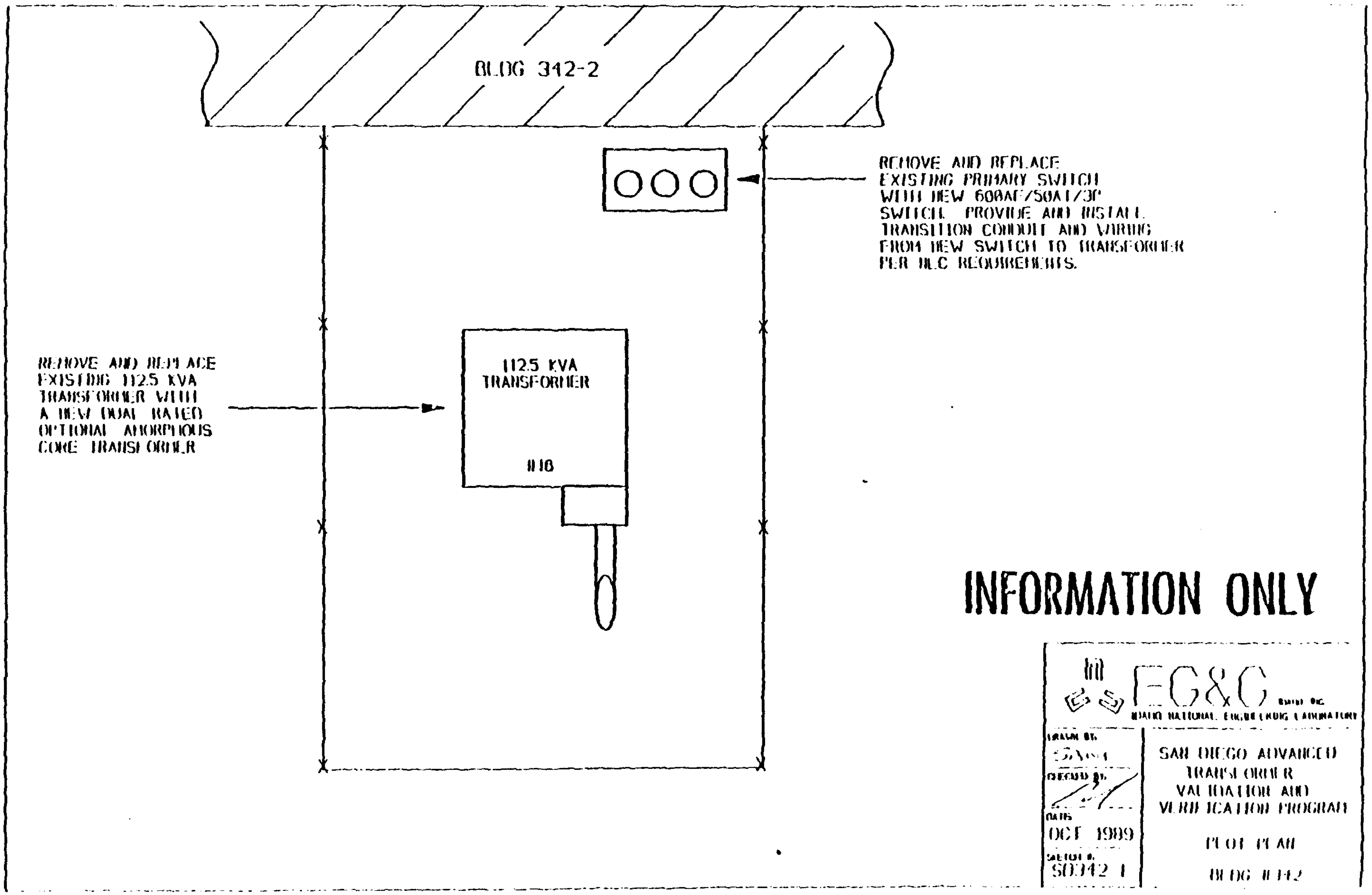
Transformer Identification	(PWC16-OLD) CC16-NEW *
Location	BLDG 342
Size	112.5 KVA **
Primary Voltage	2.4/12 KV DUAL ***
Primary Winding Type	DELTA
Secondary Voltage	480/277 V
Secondary Winding Type	WYE-GROUNDED
Percent Impedance	3.0
Primary Switch	NEW 3 POLE 15KV 50AF FUSED
Primary Connection	TRANSITION AND CABLE TO NEW SWITCH
Secondary Connections	REUSE EXISTING --- SPLICE TERMINATION FOR CONNECTIONS TO EXISTING SWITCHGEAR
Secondary Breaker	REUSE EXISTING BREAKER -NO CHANGES
Maximum No-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP
Maximum Full-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP

* Replacement of existing 112.5 KVA PCB transformer.

** Optionally propose and construct this unit with an amorphous stacked core, as per specification.

*** Dual voltage primary winding is an option. Regardless of whether the option is exercised, the 2400 VAC primary must be supplied. If the option is exercised then taps shall be provided for the higher rating (12 KV).

ES-81333



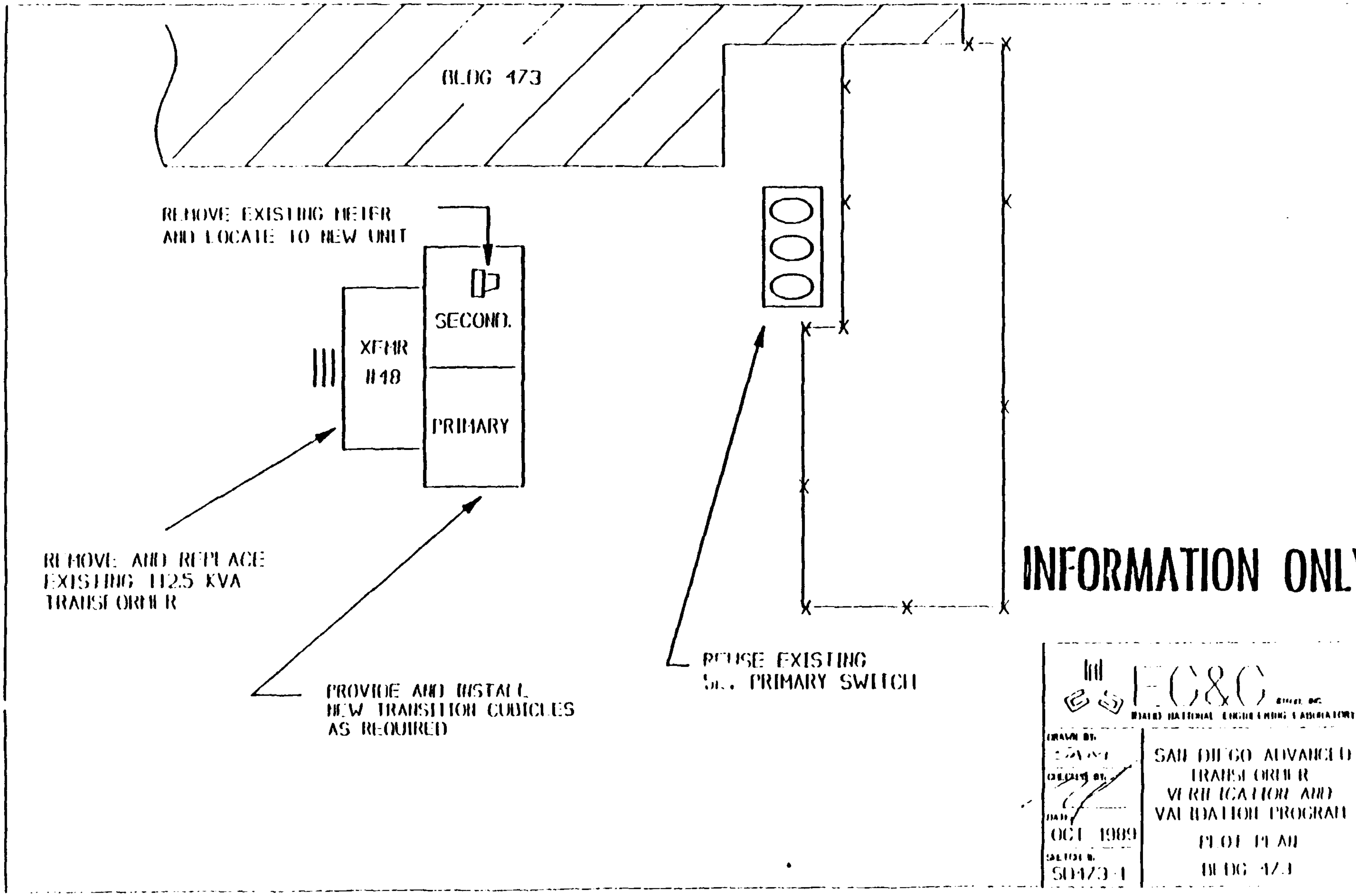
BLDG 342-2
REMOVE AND REPLACE EXISTING PRIMARY SWITCH WITH NEW 600AF/50AT/3P SWITCH. PROVIDE AND INSTALL TRANSITION CONDUIT AND WIRING FROM NEW SWITCH TO TRANSFORMER PER NEC REQUIREMENTS.
112.5 KVA TRANSFORMER
#18
REMOVE AND REPLACE EXISTING 112.5 KVA TRANSFORMER WITH A NEW DUAL RATED OPTIONAL AMORPHOUS CORE TRANSFORMER
INFORMATION ONLY
EG&G IDAHO INC.
IDAHO NATIONAL ENGINEERING LABORATORY
DRAWN BY
CHECKED BY
DATE
OCT 1989
SKETCH #
SD342-1
SAN DIEGO ADVANCED TRANSFORMER VALIDATION AND VERIFICATION PROGRAM
PLOT PLAN
BLDG #342

ES-51333

TRANSFORMER DATA SHEET

Transformer Identification	(PWC48-OLD) CC48-NEW *
Location	BLDG 473
Size	112.5 KVA
Primary Voltage	2.4 KV
Primary Winding Type	DELTA
Secondary Voltage	208/120
Secondary Winding Type	WYE-GROUNDED
Percent Impedance	3.0
Primary Switch	REUSE EXISTING SWITCH
Primary Connection	NEW TRANSITION TO EXISTING SWITCH
Secondary Connections	PROVIDE AND INSTALL NEW SECONDARY TRANSITION CUBICLE
Secondary Breaker	REUSE EXISTING SWITCHGEAR
Maximum No-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP
Maximum Full-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP

* Replacement of existing PCB transformer.



BLDG 473
REMOVE EXISTING METER
AND LOCATE TO NEW UNIT
SECOND.
XFMR
#48
PRIMARY
REMOVE AND REPLACE
EXISTING 112.5 KVA
TRANSFORMER
PROVIDE AND INSTALL
NEW TRANSITION CUBICLES
AS REQUIRED
REUSE EXISTING
PRIMARY SWITCH
INFORMATION ONLY
EG&G
IDAHO NATIONAL ENGINEERING LABORATORY
DRAWN BY
CHECKED BY
DATE
OCT 1989
SKETCH NO.
SD473-1
SAN DIEGO ADVANCED
TRANSFORMER
VERIFICATION AND
VALIDATION PROGRAM
PLOT PLAN
BLDG 473

ES-51333

ES-81333

TRANSFORMER DATA SHEET

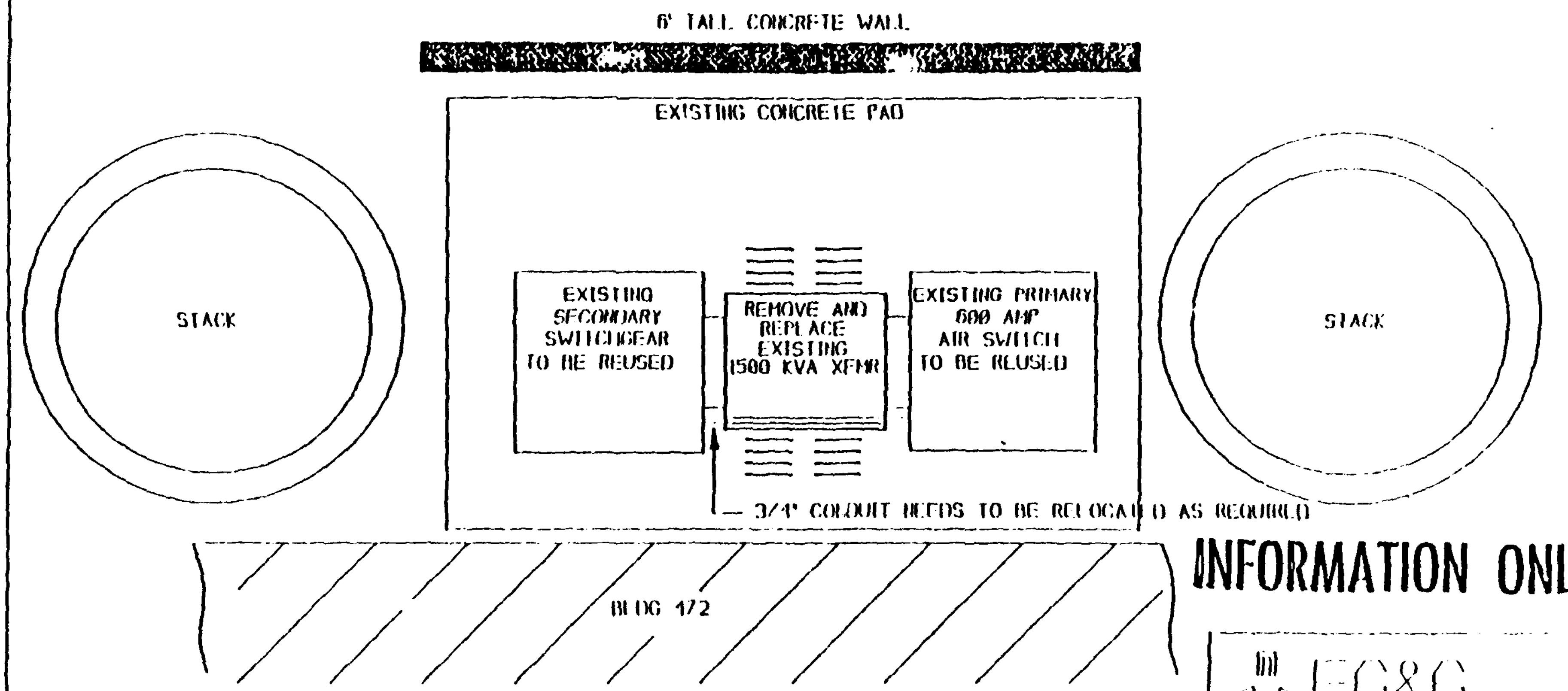
Transformer Identification	(PWC45-OLD) C045-NEW *
Location	BLDG 472 OUTDOORS **
Size	1500 KVA
Primary Voltage	12 KV
Primary Winding Type	DELTA
Secondary Voltage	480/277 V
Secondary Winding Type	WYE-GROUNDED
Percent Impedance	5.75
Primary Switch	REUSE OF EXISTING SWITCH ***
Primary connection	NEW TRANSITION TO EXISTING SWITCH
Secondary Connections	COPPER BUS CONNECTIONS TO NEW SWITCHGEAR
Secondary Breaker	REUSE EXISTING BREAKER AND SWITCH-GEAR ***
Maximum No-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP
Maximum Full-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP

* This will replace existing PCB 1500 KVA transformer.

** Use corrosion resistant external packaging, NEMA 3R minimum. Also provide optional cost to include stainless steel rain cap.

*** Include cost proposal to replace these switches as an option.

ES-81333



INFORMATION ONLY

NOTE: A CRANE WILL BE REQUIRED TO REMOVE THE EXISTING TRANSFORMER AND TO INSTALL THE NEW TRANSFORMER

REPLACEMENT OF PRIMARY AND SECONDARY SWITCHGEAR IS NOT REQUIRED, BUT REPLACEMENT PROPOSALS WILL BE SOLICITED AS OPTIONS IN THIS PACKAGE

EG&G IDAHO, INC
IDAHO NATIONAL ENGINEERING LABORATORY

DRAWN BY:	SAN DIEGO ADVANCED TRANSFORMER VALIDATION AND VERIFICATION PROGRAM
CHECKED BY:	
DATE: NOV 1989	NEW PLOT PLAN BUILDING 472
SD472 1	

ES-51333

TRANSFORMER DATA SHEET

Transformer Identification	(PWC26-OLD) CC26-NEW *
Location	BLDG 378-6 OUTDOOR
Size	500 KVA
Primary Voltage	12 KV
Primary Winding Type	DELTA
Secondary Voltage	480/277 V
Secondary Winding Type	WYE-GROUNDED
Percent Impedance	5.75
Primary Switch	REUSE EXISTING AIR INTERRUPTER SWITCH 600 A
Primary Connection	TRANSITION FROM EXISTING SWITCH
Secondary Connections	PROVIDE AND INSTALL NEW CONNECTIONS TO EXISTING SWITCHGEAR EXTEND IF REQUIRED
Secondary Breaker	REUSE EXISTING 800 A SECONDARY BREAKER AND SWITCHGEAR
Maximum No-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP
Maximum Full-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP

* Replacing existing 500 KVA PCB transformer.

No diagram provided.

TRANSFORMER DATA SHEET

Transformer Identification	(PWC27-OLD) CC27A-NEW *
Location	BLDG 378-1
Size	750/1000 KVA **
Primary Voltage	12 KV
Primary Winding Type	DELTA
Secondary Voltage	480 V
Secondary Winding Type	WYE-GROUNDED
Percent Impedance	5.75
Primary Switch	PROVIDE AND INSTALL NEW 15 KV CLASS PRIMARY SWITCH AND NEW 12 KV FEEDER
Primary Connection	TRANSITION TO NEW SWITCH
Secondary Connections	NEW COPPER BUS CONNECTIONS TO NEW SWITCHGEAR
Secondary Breaker	P & I NEW SWITCHGEAR. SEE SKETCH BREAKER AND SWITCHGEAR
Maximum No-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP
Maximum Full-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP

* This unit is replacing an existing 1000 KVA PCB filled transformer.

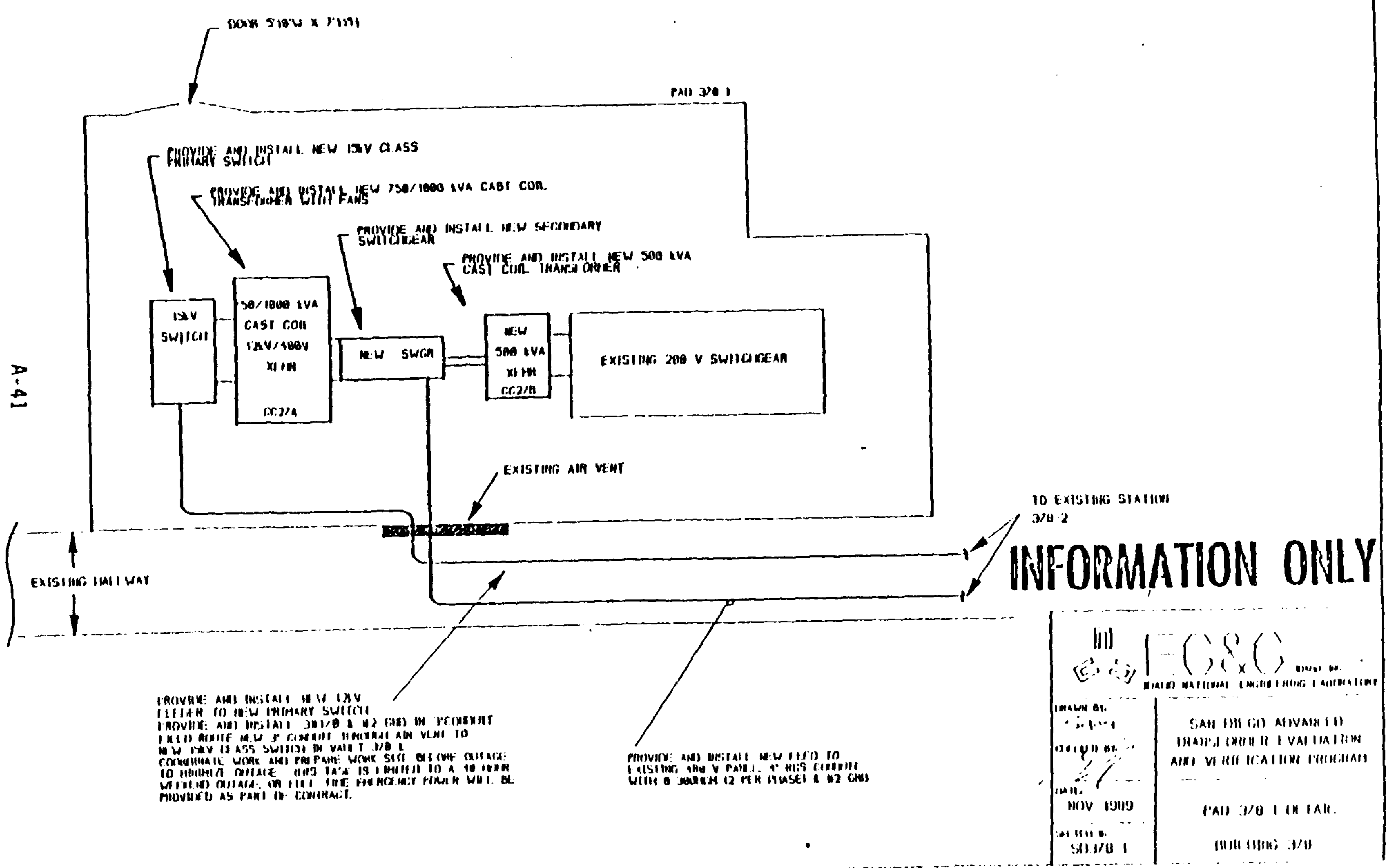
** Supply fans to achieve higher rating.

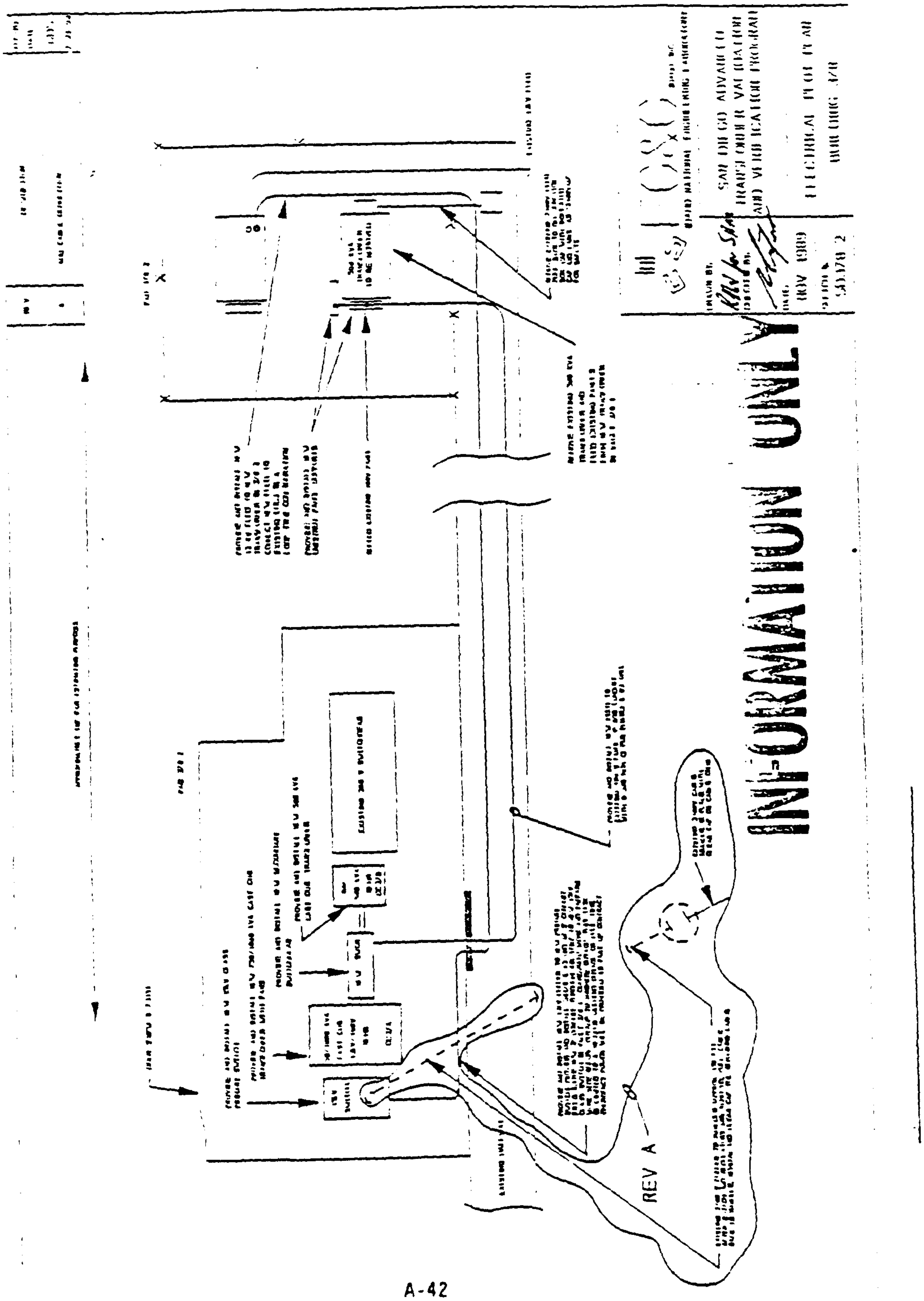
ES-51333

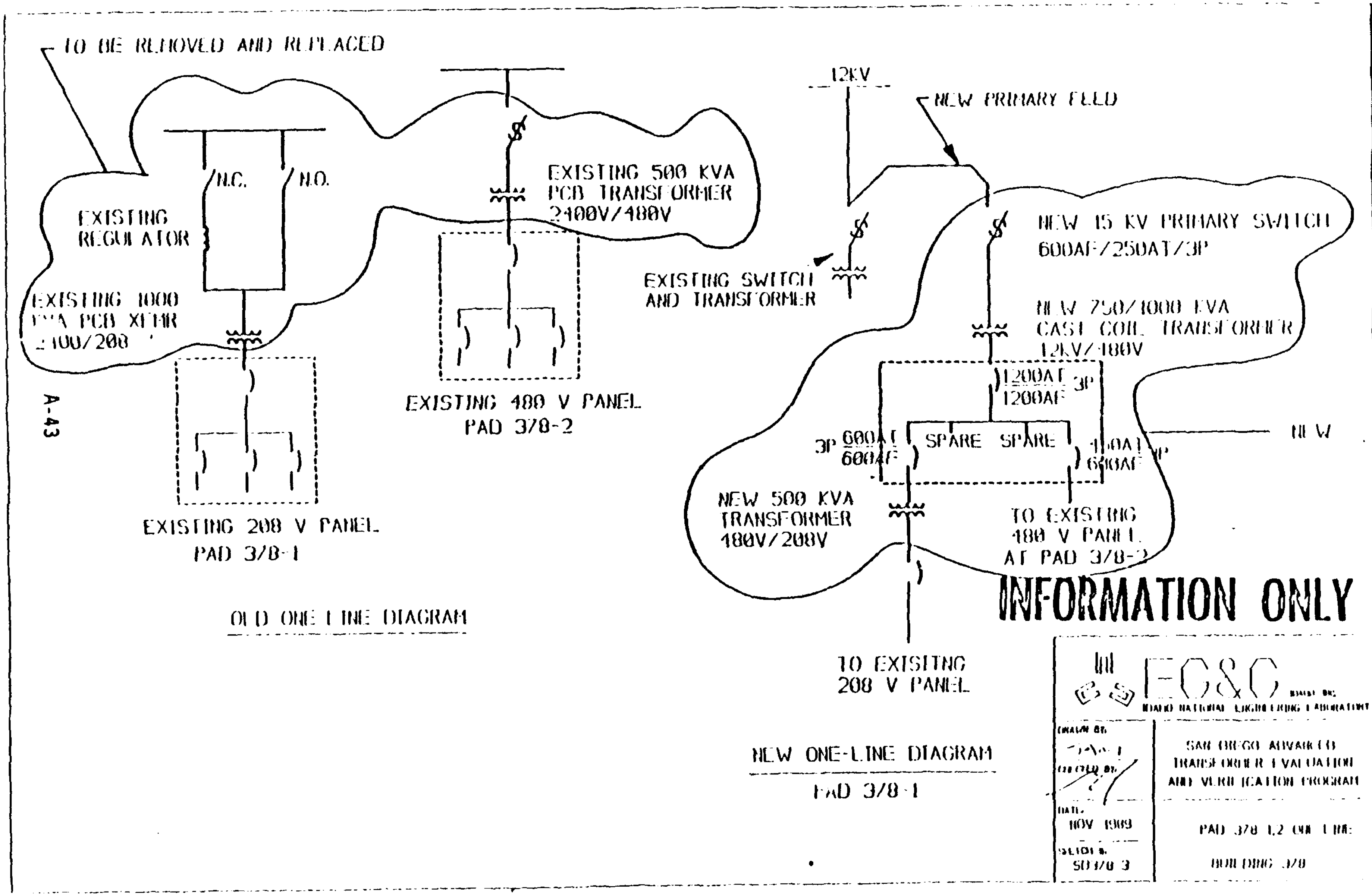
TRANSFORMER DATA SHEET

Transformer Identification	(PWC27-OLD) CC27B-NEW
Location	BLDG 378-1
Size	500 KVA *
Primary Voltage	480 V
Primary Winding Type	DELTA
Secondary Voltage	208 V
Secondary Winding Type	WYE-GROUNDED
Percent Impedance	5.75
Primary Switch	PROVIDE AND INSTALL NEW SWITCHGEAR SEE SKETCH
Primary Connection	TRANSITION FROM NEW SWITCHGEAR
Secondary Connections	NEW COPPER BUS CONNECTIONS TO EXISTING SWITCHGEAR
Secondary Breaker	REUSE EXISTING SWITCHGEAR
Maximum No-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP
Maximum Full-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP

* No primary voltage taps are required on this transformer due to the high current level. Note requested optional price for addition of standard primary voltage taps on this unit in the pricing schedule.


PAD 370 1
PROVIDE AND INSTALL NEW 15KV CLASS PRIMARY SWITCH
PROVIDE AND INSTALL NEW 750/1000 KVA CAST COIL TRANSFORMER WITH FANS
PROVIDE AND INSTALL NEW SECONDARY SWITCHGEAR
PROVIDE AND INSTALL NEW 500 KVA CAST COIL TRANSFORMER
15KV SWITCH
50/1000 KVA CAST COIL 12KV/480V XFMR CC27A
NEW SWGR
NEW 500 KVA XFMR CC27B
EXISTING 208 V SWITCHGEAR
EXISTING AIR VENT
TO EXISTING STATION 370 2
EXISTING HALLWAY
INFORMATION ONLY
NOV 1989
SAN DIEGO ADVANCED TRANSFORMER EVALUATION AND VERIFICATION PROGRAM
IDAHO NATIONAL ENGINEERING LABORATORY


INFORMATION ONLY
REV A


TO BE REMOVED AND REPLACED
N.C.
N.O.
EXISTING REGULATOR
EXISTING 1000 KVA PCB XFMR 2400/208
EXISTING 500 KVA PCB TRANSFORMER 2400V/480V
EXISTING 208 V PANEL PAD 378-1
EXISTING 480 V PANEL PAD 378-2
OLD ONE LINE DIAGRAM
12KV
NEW PRIMARY FEED
EXISTING SWITCH AND TRANSFORMER
NEW 15 KV PRIMARY SWITCH 600AF/250AT/3P
NEW 750/1000 KVA CAST COIL TRANSFORMER 12KV/480V
1200AT 3P 1200AF
3P 600AT 600AF
SPARE
SPARE
NEW
NEW 500 KVA TRANSFORMER 480V/208V
TO EXISTING 480 V PANEL AT PAD 378-2
TO EXISTING 208 V PANEL
NEW ONE-LINE DIAGRAM
PAD 378-1
INFORMATION ONLY
EG&G
IDAHO NATIONAL ENGINEERING LABORATORY
DRAWN BY
CHECKED BY
DATE
NOV 1989
SAN DIEGO ADVANCED TRANSFORMER EVALUATION AND VERIFICATION PROGRAM
PAD 378 1,2 ONE LINE
BUILDING 378

ES-51333

TRANSFORMER DATA SHEET

Transformer Identification	(PWC49-OLD) CC49-NEW *
Location	BLDG 489-1
Size	1500 KVA
Primary Voltage	12 KV
Primary Winding Type	DELTA
Secondary Voltage	480/277 V
Secondary Winding Type	WYE-GROUNDED
Percent Impedance	5.75
Primary Switch	REINSTALL EXISTING PRIMARY SWITCH
Primary Connection	CONNECT EXISTING SWITCH
Secondary Connections	NEW COPPER BUS CONNECTIONS TO EXISTING SWITCHGEAR
Secondary Breaker	EXISTING SWITCHGEAR
Maximum No-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP
Maximum Full-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP

* The existing PCB unit is already missing and will not have to be handled as part of this changeout.

Note: This unit will be installed in an existing station. The installer will have to remove an existing temporary transformer and place it aside for removal by others prior to installing the new transformer. The installer will also have to reinstall the existing primary switch, which was disconnected while the temporary transformer was installed. The existing temporary transformer is a 3750 KVA unit and will require an oversized crane to lift out and set on the ground. This unit is nonPCB and will not require additional handling.

No diagram provided.

ES-51333

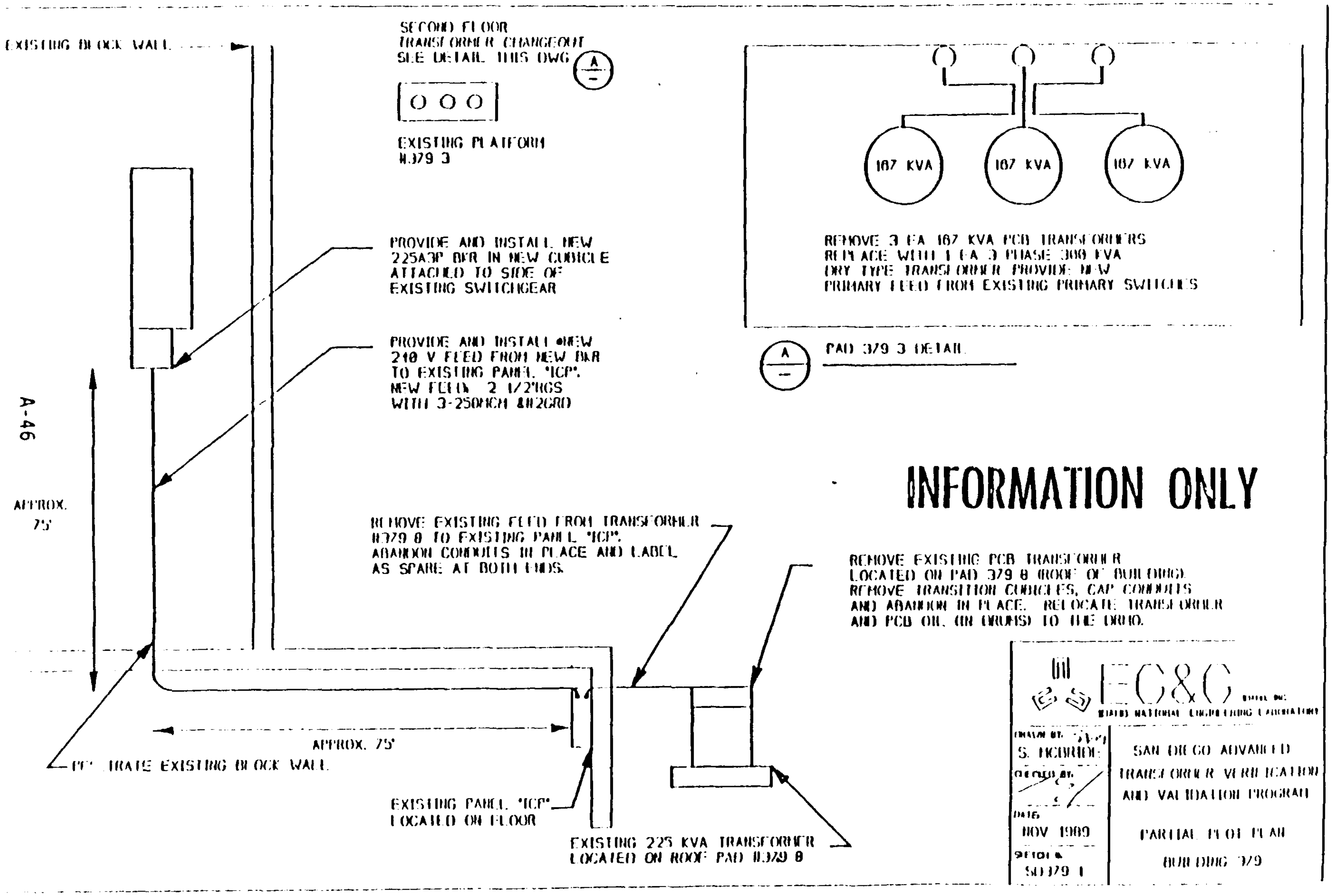
TRANSFORMER DATA SHEET

Transformer Identification	(PWC1-220,1,2-OLD) CC1-220-NEW *
Location	BLDG 379-3
Size	300 KVA
Primary Voltage	2.4/12 KV DUAL **
Primary Winding Type	DELTA
Secondary Voltage	240 V
Secondary Winding Type	WYE-GROUNDED
Percent Impedance	4.5
Primary Switch	REUSE EXISTING PRIMARY SWITCH ***
Primary Connection	PROVIDE NEW CABLE CONNECTIONS TO EXISTING SWITCH
Secondary Connections	PROVIDE NEW CONDUIT AND CONDUCTORS TO EXISTING SWITCHGEAR
Secondary Breaker	REUSE EXISTING SWITCHGEAR
Maximum No-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP
Maximum Full-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP

* This new three phase transformer is replacing three existing 167 KVA single phase PCB transformers.

** Dual voltage primary winding is an option. Regardless of whether the option is exercised, the 2400 VAC primary must be supplied. If the option is exercised then taps shall be provided for the higher rating (12 KV).

*** There are three oil-fused contactors which are feeding the transformer to be removed. It is believed that the three contactors are PCB-contaminated, and they should not be disturbed.



EXISTING BLOCK WALL
SECOND FLOOR TRANSFORMER CHANGEOUT SEE DETAIL THIS DWG (A/–)
EXISTING PLATFORM #379 3
PROVIDE AND INSTALL NEW 225A3P BKR IN NEW CUBICLE ATTACHED TO SIDE OF EXISTING SWITCHGEAR
PROVIDE AND INSTALL NEW 240 V FEED FROM NEW BKR TO EXISTING PANEL "ICP". NEW FEED: 2 1/2"RGS WITH 3-250MCM &#2GRD
187 KVA
187 KVA
187 KVA
REMOVE 3 EA 187 KVA PCB TRANSFORMERS REPLACE WITH 1 EA 3 PHASE 300 KVA DRY TYPE TRANSFORMER. PROVIDE NEW PRIMARY FEED FROM EXISTING PRIMARY SWITCHES
PAD 379 3 DETAIL
INFORMATION ONLY
APPROX. 75'
REMOVE EXISTING FEED FROM TRANSFORMER #379 8 TO EXISTING PANEL "ICP". ABANDON CONDUITS IN PLACE AND LABEL AS SPARE AT BOTH ENDS.
REMOVE EXISTING PCB TRANSFORMER LOCATED ON PAD 379 8 (ROOF OF BUILDING). REMOVE TRANSITION CUBICLES, CAP CONDUITS AND ABANDON IN PLACE. RELOCATE TRANSFORMER AND PCB OIL (IN DRUMS) TO THE DRMO.
APPROX. 75'
PENETRATE EXISTING BLOCK WALL
EXISTING PANEL "ICP" LOCATED ON FLOOR
EXISTING 225 KVA TRANSFORMER LOCATED ON ROOF PAD #379 8
EG&G IDAHO INC.
IDAHO NATIONAL ENGINEERING LABORATORY
DRAWN BY: S. MCBRIDE
CHECKED BY:
DATE: NOV 1989
SKETCH #: SD379 1
SAN DIEGO ADVANCED TRANSFORMER VERIFICATION AND VALIDATION PROGRAM
PARTIAL PLOT PLAN
BUILDING 379

TRANSFORMER DATA SHEET

Transformer Identification	(PWC1-158-OLD) CC1-158-NEW *
Location	BLDG 333-1 **
Size	112.5 KVA
Primary Voltage	480 V
Primary Winding Type	DELTA
Secondary Voltage	208/120 V
Secondary Winding Type	WYE-GROUNDED
Percent Impedance	4.5
Primary Switch	PROVIDE AND INSTALL NEW 480 V BREAKER IN NEW SWITCHGEAR. SEE SKETCHES
Primary Connection	SEE SKETCHES
Secondary Connections	TRANSITION TO EXISTING PANEL
Secondary Breaker	REUSE EXISTING
Maximum No-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP
Maximum Full-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP

* This unit replaces the existing 112.5 KVA PCB transformer.

** This transformer will be installed on a mezzanine located approximately 30 feet AAF. Extra rigging and PCB handling efforts will be required.

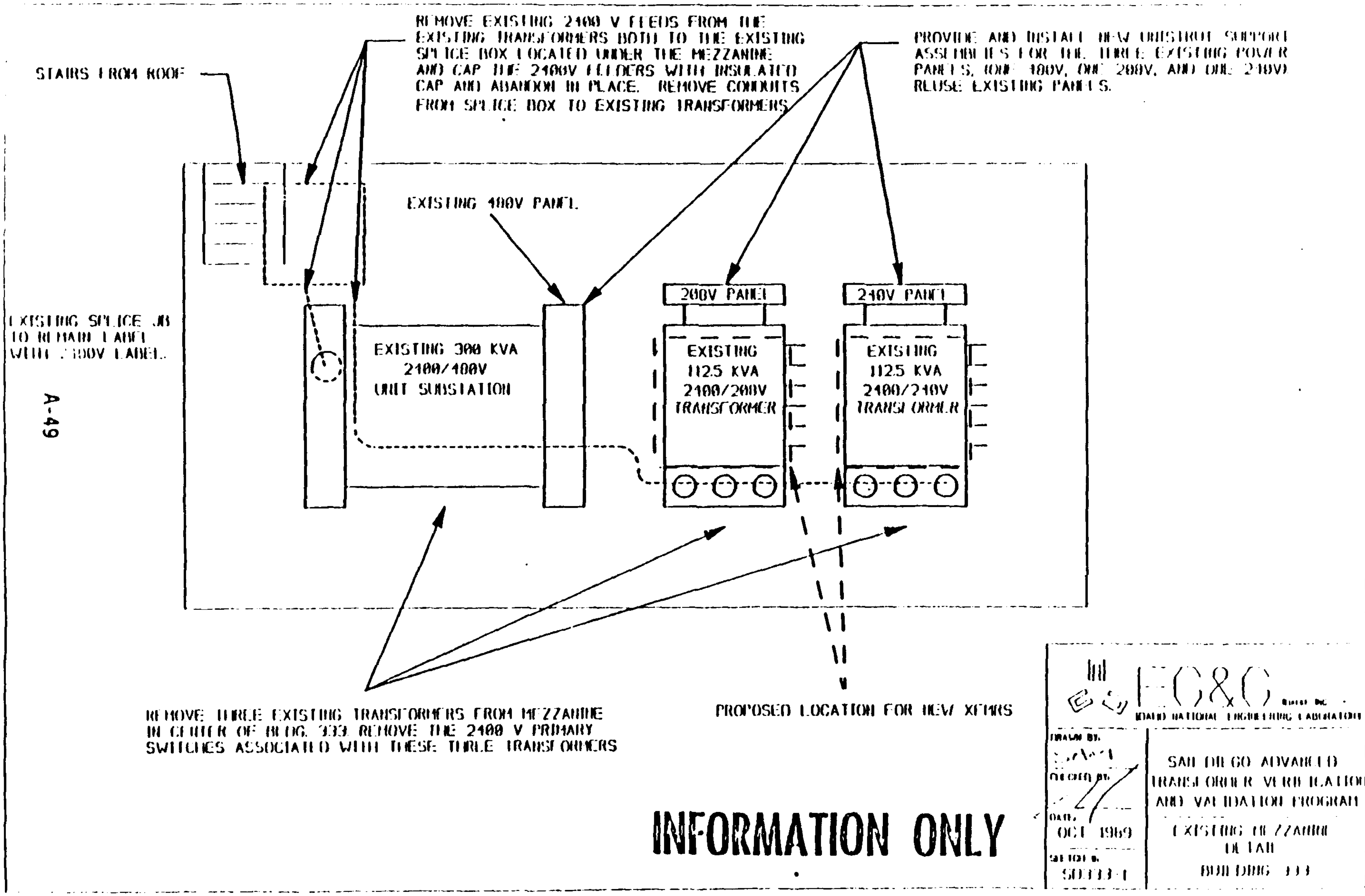
ES-51333

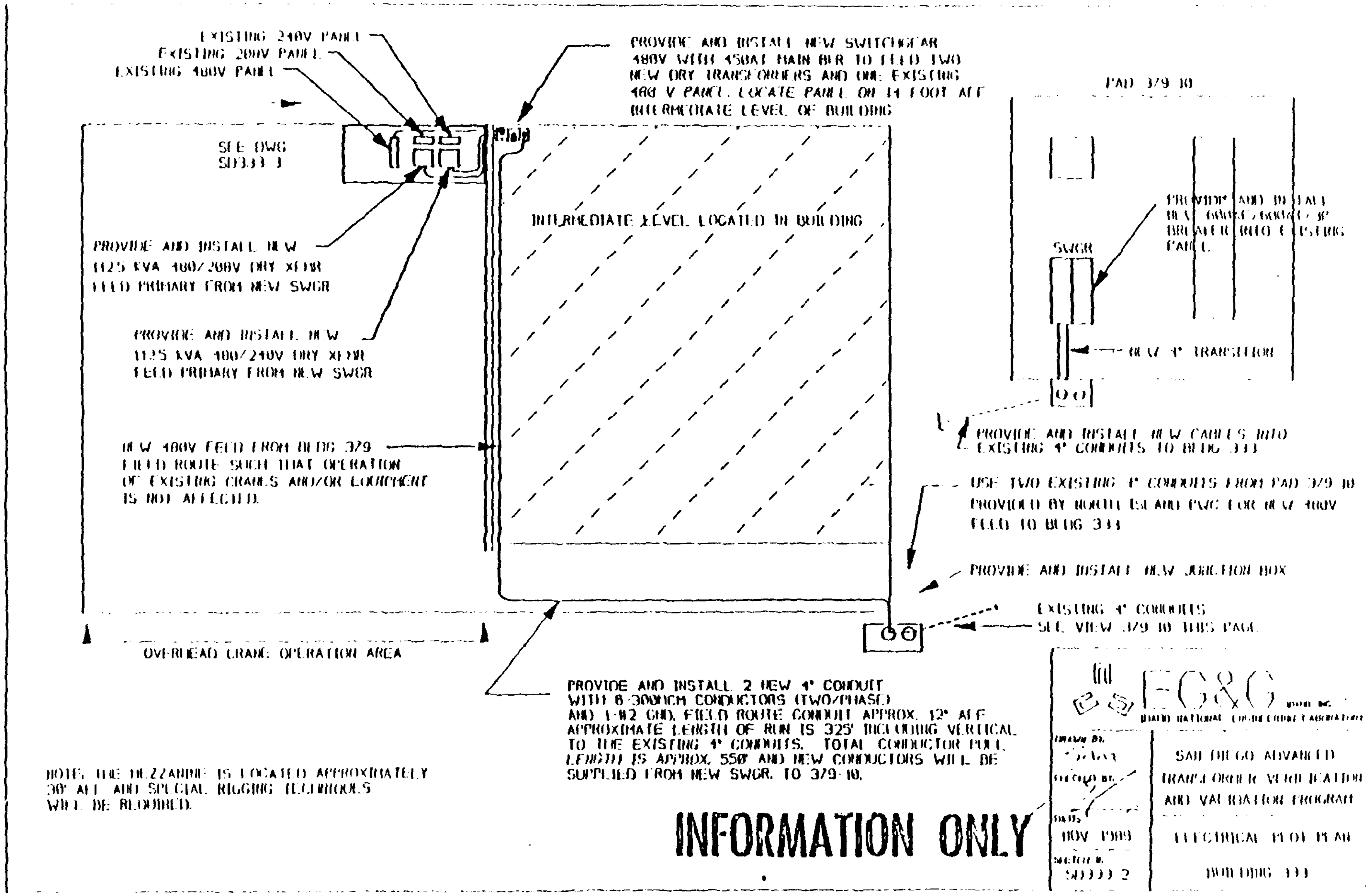
TRANSFORMER DATA SHEET

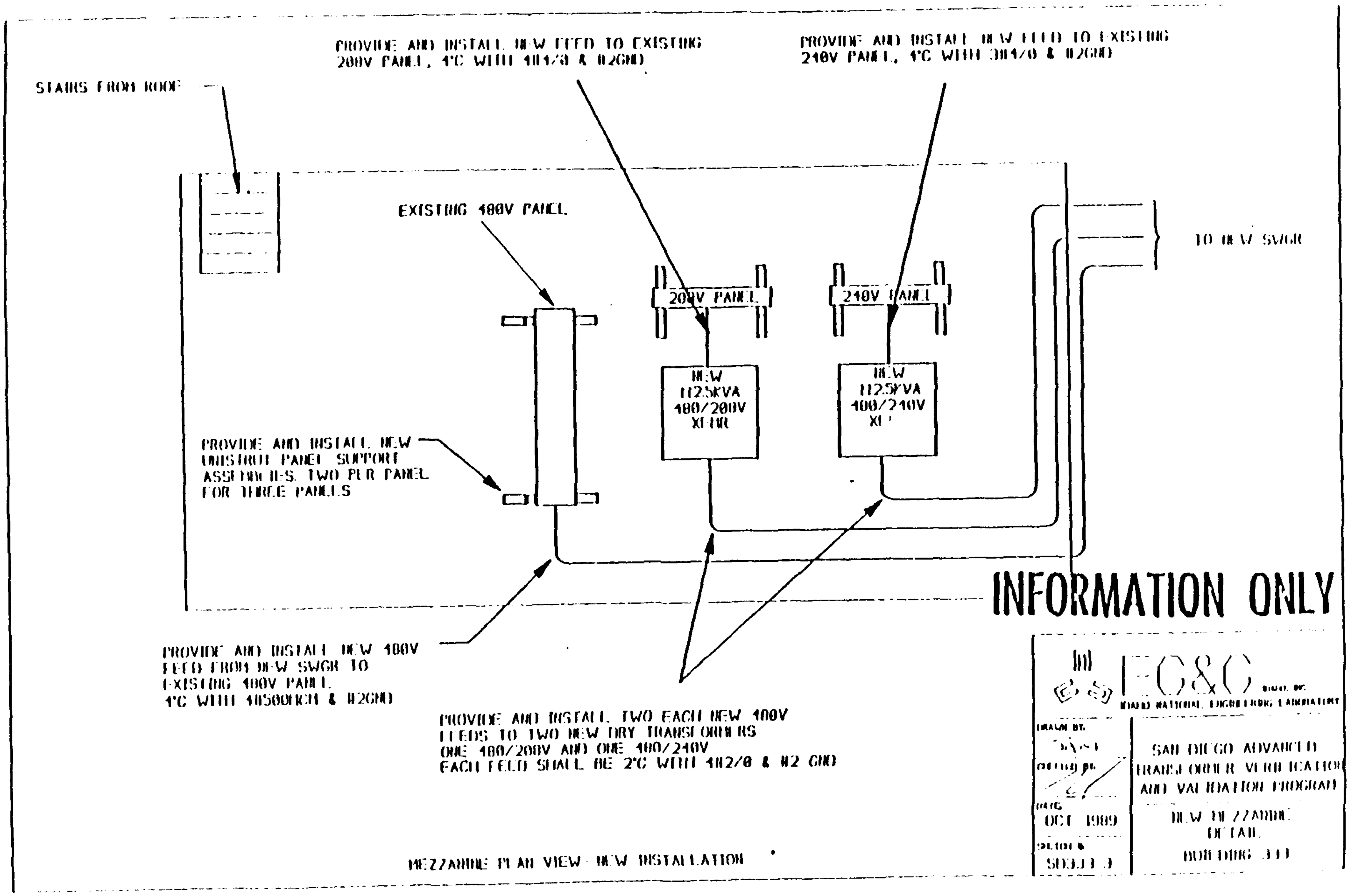
Transformer Identification	(PWC1-157-OLD) CC1-157-NEW *
Location	BLDG 333-1 **
Size	112.5 KVA
Primary Voltage	480 V
Primary Winding Type	DELTA
Secondary Voltage	240 V
Secondary Winding Type	WYE
Percent Impedance	4.5
Primary Switch	PROVIDE AND INSTALL NEW 480 V BREAKER IN NEW SWITCHGEAR. SEE SKETCHES.
Primary Connection	SEE SKETCHES
Secondary Connections	TRANSITION TO EXISTING PANEL
Secondary Breaker	REUSE EXISTING BREAKER
Maximum No-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP
Maximum Full-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP

* This unit is replacing the existing 112.5 KVA PCB transformer.

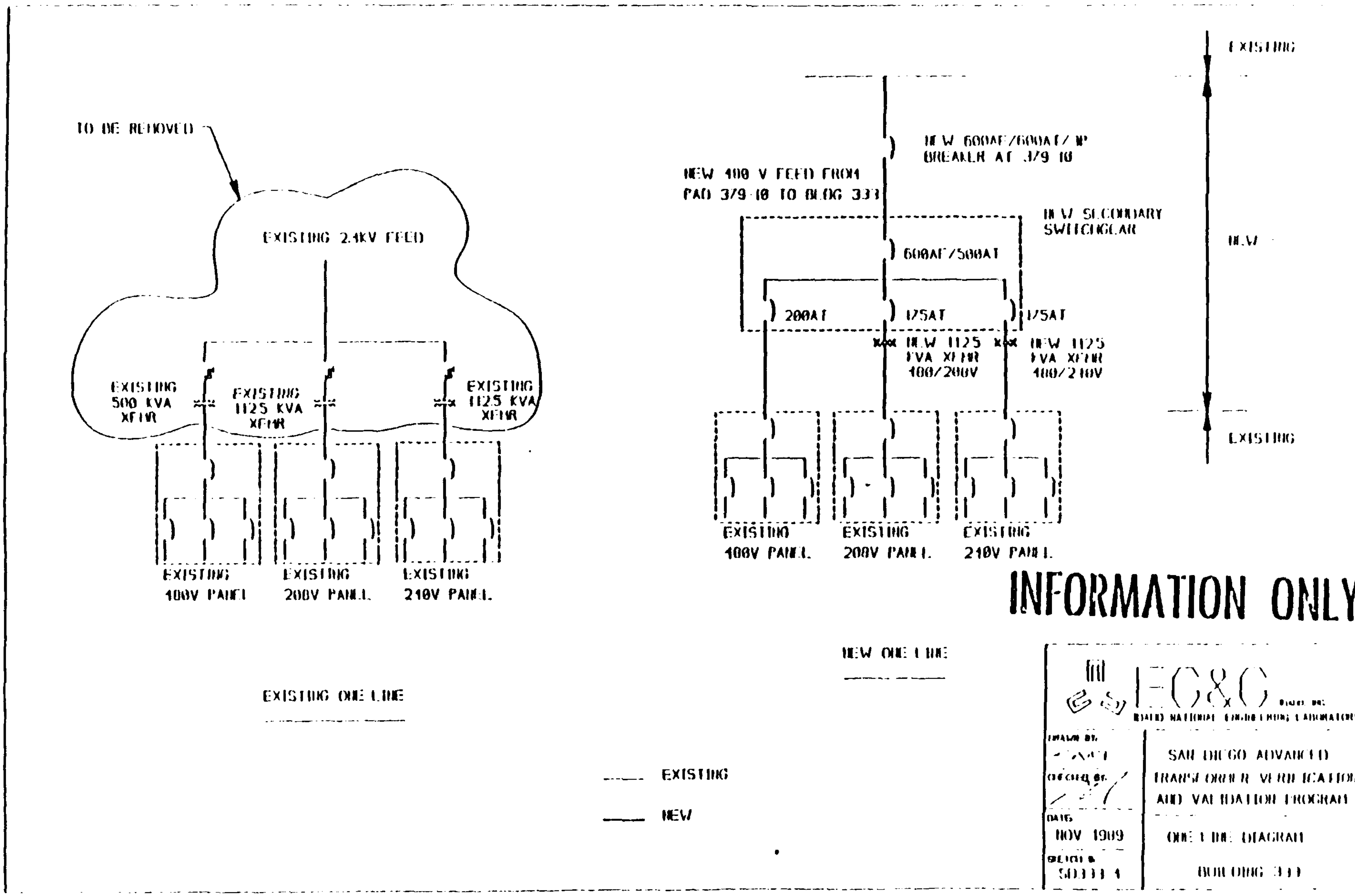
** This transformer will be installed on a mezzanine located approximately 30 feet AFF. Extra rigging and PCB handling efforts will be required.


STAIRS FROM ROOF
REMOVE EXISTING 2400 V FEEDS FROM THE EXISTING TRANSFORMERS BOTH TO THE EXISTING SPLICE BOX LOCATED UNDER THE MEZZANINE AND CAP THE 2400V FEEDERS WITH INSULATED CAP AND ABANDON IN PLACE. REMOVE CONDUITS FROM SPLICE BOX TO EXISTING TRANSFORMERS
PROVIDE AND INSTALL NEW UNISTRUT SUPPORT ASSEMBLIES FOR THE THREE EXISTING POWER PANELS, (ONE 480V, ONE 208V, AND ONE 240V) REUSE EXISTING PANELS.
EXISTING 480V PANEL
200V PANEL
240V PANEL
EXISTING SPLICE JB TO REMAIN LABEL WITH 2400V LABEL.
EXISTING 300 KVA 2400/480V UNIT SUBSTATION
EXISTING 112.5 KVA 2400/208V TRANSFORMER
EXISTING 112.5 KVA 2400/240V TRANSFORMER
REMOVE THREE EXISTING TRANSFORMERS FROM MEZZANINE IN CENTER OF BLDG. 333. REMOVE THE 2400 V PRIMARY SWITCHES ASSOCIATED WITH THESE THREE TRANSFORMERS
PROPOSED LOCATION FOR NEW XFMRS
INFORMATION ONLY
EG&G
IDAHO NATIONAL ENGINEERING LABORATORY
DRAWN BY
CHECKED BY
DATE
OCT 1989
SAN DIEGO ADVANCED TRANSFORMER VERIFICATION AND VALIDATION PROGRAM
EXISTING MEZZANINE DETAIL
BUILDING 333


EXISTING 240V PANEL
EXISTING 208V PANEL
EXISTING 480V PANEL
SEE DWG SD333 3
PROVIDE AND INSTALL NEW SWITCHGEAR 480V WITH 450AT MAIN BKR TO FEED TWO NEW DRY TRANSFORMERS AND ONE EXISTING 480 V PANEL. LOCATE PANEL ON 14 FOOT AFF INTERMEDIATE LEVEL OF BUILDING
PAD 379 10
INTERMEDIATE LEVEL LOCATED IN BUILDING
PROVIDE AND INSTALL NEW 112.5 KVA 480/208V DRY XFMR FEED PRIMARY FROM NEW SWGR
PROVIDE AND INSTALL NEW 112.5 KVA 480/240V DRY XFMR FEED PRIMARY FROM NEW SWGR
SWGR
NEW 4" TRANSITION
NEW 480V FEED FROM BLDG 379 FIELD ROUTE SUCH THAT OPERATION OF EXISTING CRANES AND/OR EQUIPMENT IS NOT AFFECTED.
PROVIDE AND INSTALL NEW CABLES INTO EXISTING 4" CONDUITS TO BLDG 333
USE TWO EXISTING 4" CONDUITS FROM PAD 379 10 PROVIDED BY NORTH ISLAND PWC FOR NEW 480V FEED TO BLDG 333
PROVIDE AND INSTALL NEW JUNCTION BOX
EXISTING 4" CONDUITS SEE VIEW 379 10 THIS PAGE
OVERHEAD CRANE OPERATION AREA
PROVIDE AND INSTALL 2 NEW 4" CONDUIT WITH 6-300MCM CONDUCTORS (TWO/PHASE) AND 1-#2 GND. FIELD ROUTE CONDUIT APPROX. 12' AFF APPROXIMATE LENGTH OF RUN IS 325' INCLUDING VERTICAL TO THE EXISTING 4" CONDUITS. TOTAL CONDUCTOR PULL LENGTH IS APPROX. 550' AND NEW CONDUCTORS WILL BE SUPPLIED FROM NEW SWGR. TO 379-10.
NOTE: THE MEZZANINE IS LOCATED APPROXIMATELY 30' AFF AND SPECIAL RIGGING TECHNIQUES WILL BE REQUIRED.
INFORMATION ONLY
EG&G IDAHO INC.
IDAHO NATIONAL ENGINEERING LABORATORY
DRAWN BY
CHECKED BY
DATE
NOV 1989
SKETCH NO.
SD333 2
SAN DIEGO ADVANCED TRANSFORMER VERIFICATION AND VALIDATION PROGRAM
ELECTRICAL PLOT PLAN
BUILDING 333



PROVIDE AND INSTALL NEW FEED TO EXISTING 208V PANEL, 4°C WITH 4#4/0 & #2GND
PROVIDE AND INSTALL NEW FEED TO EXISTING 240V PANEL, 4°C WITH 3#4/0 & #2GND
STAIRS FROM ROOF
EXISTING 480V PANEL
208V PANEL
240V PANEL
TO NEW SWGR
NEW 112.5KVA 480/208V XFMR
NEW 112.5KVA 480/240V
PROVIDE AND INSTALL NEW UNISTRUT PANEL SUPPORT ASSEMBLIES. TWO PER PANEL FOR THREE PANELS
INFORMATION ONLY
PROVIDE AND INSTALL NEW 480V FEED FROM NEW SWGR TO EXISTING 480V PANEL. 4°C WITH 4#500MCM & #2GND
PROVIDE AND INSTALL TWO EACH NEW 480V FEEDS TO TWO NEW DRY TRANSFORMERS ONE 480/208V AND ONE 480/240V EACH FEED SHALL BE 2°C WITH 4#2/0 & #2 GND
MEZZANINE PLAN VIEW NEW INSTALLATION
EG&G
IDAHO NATIONAL ENGINEERING LABORATORY
DRAWN BY
CHECKED BY
DATE
OCT 1989
SAN DIEGO ADVANCED TRANSFORMER VERIFICATION AND VALIDATION PROGRAM
NEW MEZZANINE DETAIL
BUILDING


TO BE REMOVED
EXISTING 2.4KV FEED
EXISTING 500 KVA XFMR
EXISTING 1125 KVA XFMR
EXISTING 1125 KVA XFMR
EXISTING 480V PANEL
EXISTING 208V PANEL
EXISTING 240V PANEL
EXISTING ONE LINE
NEW 600AF/600AT/W BREAKER AT 3/9-10
NEW 480 V FEED FROM PAD 3/9-10 TO BLDG 333
NEW SECONDARY SWITCHGEAR
600AF/500AT
200AT
175AT
175AT
NEW 1125 KVA XFMR 480/208V
NEW 1125 KVA XFMR 480/240V
EXISTING 480V PANEL
EXISTING 208V PANEL
EXISTING 240V PANEL
EXISTING
NEW
EXISTING
NEW ONE LINE
EXISTING
NEW
INFORMATION ONLY
EG&G IDAHO NATIONAL ENGINEERING LABORATORY
DRAWN BY
CHECKED BY
DATE NOV 1989
SD333-1
SAN DIEGO ADVANCED TRANSFORMER VERIFICATION AND VALIDATION PROGRAM
ONE LINE DIAGRAM
BUILDING 333

APPENDIX B

VENDOR DATA REQUIREMENT LIST

APPENDIX B

VENDOR DATA REQUIREMENTS LIST

Description	* When Required	Copies Required	No. of Reference Paragraph		** Approval Req'd. by
1. Drawings, sketches, schematics and other data shall be submitted with the bid sufficient for evaluation of contract proposal.	BC	12	NA	R	AB/DE
2. Quality Manual and Procedures	BC	12	4.0	R	AB/DE
3. Inspection and Test Procedures	BFR	12	3.2, 3.10	I	AB/DE
4. Inspection and Test Results	PS	12	3.10	R	AB/DE
5. Maintenance manual which includes as a minimum: installation instructions, operating instructions, preventive and corrective maintenance tasks, the frequency of each task, the tools, equipment, and procedures with special emphasis on safety precautions for the accomplishments of each task.	PS	12	5.0	I	AB/DE
6. Priced spare parts list and recommended spares.	PS	12	5.0	I	AB/D
7. Guaranteed performance data and name plate data.	PS	12	5.0	I	AB/DE
8. As-built shop drawings schematics and wiring diagram.	PS	12	5.0	R	AB/DE
9. Installation schedule.	PS	12	5.0		AB/DE
10. PCB fluid disposal plan and certification.	PS	12	5.0		AB/DE
11. Spill Prevention, Control, and Countermeasures Plan	BFR	12	NA	R	AB/DE
12. Certification for Hazardous Waste Handlers	PS	12	NA	R	AB/DE

* BFR = Before Fabrication Release
* PS = Prior to Shipment
** I = Information Only
** DE = Approval By Design Engineer
* BC = Before contract is awarded
** R = Required
** AB = Approval By Buyer

APPENDIX C

CONSTRUCTION DETAILS

CONSTRUCTION DETAILS

ELECTRICAL GENERAL PROVISIONS

PART I - GENERAL

DESCRIPTION OF WORK:

Summary: The electrical work can be generally summarized in the following manner, but this is not by way of limitation:

- Obtain permits for moving hazardous waste.
- Check and mark phase rotation before de-energizing system.
- Have PWC personnel de-energize the existing transformers.
- Test existing transformer for no-load losses. Drain the PCB fluid from each transformer into standard DOT approved drums and deliver it to the interim hazardous waste storage area on the base as designated by the Resident Engineer (all work shall comply with OSHA and EPA regulations).
- Purge the transformer case with dry nitrogen and seal.
- Deliver the existing transformer to the interim hazardous waste storage area on the base (comply with OSHA and EPA regulations).
- Provide and install new transformers.
- Connect new transformers and test.
- Request PWC personnel to energize the system.
- Verify proper operations and turn the operating transformer over to EG&G Idaho, Inc. for remanding to PWC San Diego.

PART 2 - MISCELLANEOUS AND ANCILLARY PRODUCTS

GENERAL:

Furnish all labor, materials, equipment, and appliances required to complete the installation of the complete electrical systems. All labor, materials, service, equipment, and workmanship shall conform to the applicable chapters of the NEC (NFPA 70) and other authorities having lawful jurisdiction pertaining to the work required. All modifications required by these codes, rules, regulations, and authorities shall be made by the Subcontractor without additional charge to the Contractor.

Underwriter's Laboratories (UL): All materials, appliances, equipment, or devices shall conform to the applicable standards of UL where such standards exist. All material, appliances, equipment, or devices shall be listed and/or labeled by UL where such standards exist.

Completed electrical system shall conform with applicable provisions of the Special Conditions, the Technical Specification, and the attached subcontract drawings.

CONDITION OF PRODUCTS:

Except as otherwise indicated, provide new electrical products, free of defects and harmful deterioration at the time of installation. Provide each product complete with trim, accessories, finish guards, safety devices, and similar components specified or recognized as integral parts of the product, or required by governing regulations.

UNIFORMITY:

Where multiple units of a product are required for the electrical work, provide identical products by the same manufacturer without variations except for sizes and similar variations as indicated.

PART 3 - EXECUTION:

COORDINATION OF ELECTRICAL WORK:

General: It is recognized that the subcontract documents are diagrammatic in showing certain physical relationships that must be established within the electrical work and in its interface with other work, including utilities and mechanical work, and that such establishment is the exclusive responsibility of the Subcontractor.

Arrange electrical work in a neat, well-organized manner with conduit and similar services running parallel with the primary lines of the building construction and with a minimum of 7 feet overhead clearance where possible.

Locate operating and control equipment properly to provide easy access and arrange entire electrical work with adequate access for operation and maintenance.

RESIDENT ENGINEER:

The EG&G Idaho Resident Engineer will ensure that the installation complies with drawings, specifications, and witness testing.

TRANSFORMERS

PART 1 - GENERAL

WORK DESCRIPTION:

Provide and install transformers of sizes, ratings, and types as shown on the referenced data sheets and engineering specification.

PART 2 - PRODUCTS

MATERIALS:

The transformers shall be as shown on the attached data sheets and shall be installed at the location indicated on the drawings.

The transformer enclosure shall be suitable for the environment that the transformer is installed in.

PART 3 - EXECUTION

INSTALLATION:

Install transformers as indicated on the drawings and in accordance with manufacturer's written instructions, applicable requirements of NEC and the NEC Association's "Standard of Installation," and complying with recognized industry practices to ensure that products serve intended functions.

TESTING:

Visually inspect to determine that equipment installation conforms to NEC, these specifications, and the drawings and testing as described under the testing section of the specification.

GROUNDING

PART 1 - GENERAL

WORK DESCRIPTION:

Provide and install grounding on all transformer cases and tie into the existing grounding system.

PART 2 - PRODUCTS

MATERIALS:

Grounding electrode wire shall be a minimum of No. 2 AWG bare stranded copper and comply with NEC Table 250-94.

Ground grid welds shall be made by the Thermit process.

PART 3 - EXECUTION

INSTALLATION:

Install a complete grounding system for the transformers in accordance with applicable requirements of NEC and complying with recognized industry practices to ensure that products serve intended functions and comply with requirements. All exposed noncurrent-carrying metallic parts of electrical equipment, conduits, grounding conductor of nonmetallic sheathed cables, and neutral conductor of the wiring system shall be grounded.

Exothermic Welds: Exothermic welds shall be made in accordance with the manufacturer's written recommendations. No mechanical connector is required at exothermic weldments.

TESTING:

Visually inspect to determine that ground installation conforms to NEC, these specifications, and the drawings.

CABLE, WIRE, CONNECTORS AND MISCELLANEOUS DEVICES

PART 1 - GENERAL

WORK DESCRIPTION:

Provide and install conduit systems, cables, wires, and wiring connectors of sizes, ratings, materials, and types as shown on the drawings.

PART 2 - PRODUCTS

WIRING MATERIALS 5 KV AND 15 KV CLASS:

All 5 KV and 15 KV cable shall be shielded and properly terminated. Cable shall be EPR MV-90 shielded cable and shall have a 133% insulation level.

HIGH VOLTAGE SPLICES:

Splices in high voltage cables. Splices shall be suitable for continuous immersion in water and shall be made only in accessible locations in manholes.

Certification. High voltage cable splicer/terminator certification of competency and experience shall be submitted 30 days before splices or terminations are made in high voltage cables. Splicer/terminator experience during the past 3 years shall include performance in splicing and terminating all cables of the type and classification being provided under this contract.

Kit Methods. High voltage splices shall be made using a "kit," which shall be the product of one manufacturer and shall have the approval in writing of the manufacturer of the cable that is to be spliced. The Contractor shall provide for continuous submersion in water.

Heat-Shrink Method. All splices for 600 volt and less cables shall be done by the heat-shrink method. Provide heavy-wall heat-shrinkable splice tubing rated for sealed underground connector systems. Tubing shall be available uncoated, or with a thermoplastic adhesive-sealant that adheres to PVC, neoprene, polyolefin, and EPR aluminum or steel.

Splices in High Voltage Cables. Splices shall be suitable for continuous immersion in water and shall be made only in accessible locations in manholes.

Certification. High voltage cable splicer/terminator certification of competency and experience shall be submitted 30 days before splices or terminations are made in high voltage cables. Splicer/terminator experience during the past 3 years shall include performance in splicing and terminating cables of the type and classification being provided under this contract.

Kit Methods. High voltage splices shall be made using a "kit," which shall be the product of one manufacturer and shall have the approval in writing of the manufacturer of the cable that is to spliced. The contractor shall provide the Contracting Officer or Contractor's Quality Control representative with a copy of the manufacturer's instructions before splicing is started. Splices shall be made only in manholes.

Splices in Shielded Cables. Splices in shielded cables shall include covering the spliced area with metallic tape, or like material, to the original cable shield and connecting it to the cable on each side of the slice. Provide a No. 6 AWG bare copper ground connection brought out in a water tight manner and ground to a 3/4 inch x 10 feet ground rod as part of the splice installation. Wire shall be trained to the sides of the enclosure in a manner to avoid interference with the working area.

Phasing and Rotation. Contractor to record the phasing and rotation of the existing electrical system before cable splicing, cable removal, termination, and/or any work that could alter the phasing and rotation of the system. After completion of the work and before connecting any load to the system, the contractor shall verify that the phasing and rotation is as it existed and has not been altered.

WIRING MATERIALS, 600 V CLASS:

Conductors shall be stranded for all sizes of wire and cable.

Conductors shall be copper for all sizes.

Wire insulation shall be type THHN/THWN for all 600 volt conductors unless otherwise noted.

Minimum size of power conductors shall be No. 12.

Splices for 600 Volt Cables. Splices in underground systems shall be made only in accessible locations, such as manholes and handholes, using a compression connector of the conductor and by insulating and water proofing by a method suitable for continuous submersion in water.

Heat-Shrink Method. All splices for 600 volt and less cable shall be done by the heat-shrink method. Provide heavy-wall heat-shrinkable splice tubing rated for sealed underground connector systems. Tubing shall be available uncoated, or with a thermoplastic adhesive-sealant that adheres to PVC, neoprene, polyolefin, and EPR aluminum or steel.

CONNECTORS:

Compression and/or lug type connectors, such as "Burndy", shall be used for splicing No. 6, and larger 600 volt cable.

High Voltage Cable Terminations. IEEE 48, Class 2. Except as otherwise indicated, terminators for extruded insulation nonmetallic jacketed cables shall be porcelain insulator type. Apply terminator to single conductor cables or to each conductor of multiple conductor cable that are to the weather. Terminator shall not exude any filler compound under either test or service. The terminator shall consist of a porcelain insulator, cable connector-hoodnut assemble, and aerial lug, as required, metal body and supporting bracket, sealed cable entrance, and internal stress relief device for shielded cable, and insulating filler compound or material.

Terminator, Modular, Molded Rubber Type. IEEE 48, Class 2. Provide terminator as specified herein for terminating single conductor, or the single conductor of multiconductors, solid insulated, nonmetallic jacketed type cables for service voltage up to 35 KV outdoor. The terminator shall consist of a stress control, ground clamp, nontracking rubber skirts, crimp-on connector, rubber cap, and aerial lug. Provide heat-shrinkable elbow sealing adaptor as shown on plans, allowing the metallic cable shielding to be externally grounded and sealed. Separate parts of copper or copper alloy shall not be used in contact with aluminum or aluminum alloy parts in the construction and installation of the terminator.

Wire/Device Identification: All cable systems, major conduits, and devices shall be permanently marked. Conduits shall have stainless steel tags at every 60 feet or where wall or building penetrations occur. All conductors shall be identified with self-adhering oil and moisture resistant vinyl labels, covered with clear heat shrink tubing or white heat shrink tubing with black typed on letters with nonsmearing ink as manufactured by Brady, T&B, or approved equal. Hand lettered labels shall not be used. All conductors shall be clearly marked with the proper phase identification.

CONDUIT SYSTEM:

All conduits shall be RGS or IMC with exception of underground, which can be PVC, and which shall be 3 feet minimum below grade and encased in 2 inches minimum red concrete. All bends must be RGS or IMC. Conduit systems shall be completed per the NEC.

PART 3 - EXECUTION

INSTALLATION:

General: Install electrical cable, wire, and connectors as indicated on the drawings, in accordance with the manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure products serve intended functions.

Pull conductors together where more than one is being installed in a raceway. Do not exceed the conductor manufacturer's recommended pulling tension or as specified in the IPCS Handbook. Use pulling compound or lubricant, where necessary; compound must not deteriorate conductor or installation. Tension shall be monitored when pulls involve more than 40 feet or when 3 or more 90 degree turns are in the system.

Use pulling means including fish tape, cable, or rope which cannot damage raceway.

Install splices and taps in an accessible junction box that has mechanical strength and insulation rating equivalent-or-better than conductor.

Use splice and tape connectors that are compatible with conductor material.

TESTING:

High Potential: After installation and installing stress cones, all 15 KV cable shall be tested at twice the normal operating voltage plus 1000 volts. The test duration shall be 15 minutes on each cable. See IEEE standard 400-1980 (IEEE guide for making high-direct-voltage tests on power cable systems in the field).

Meggering: Before terminating, test all cable or wire for insulation resistance with 500 volt megger. Any wire with less than 10 megohms to ground or other conductors shall be replaced before proceeding with the terminating. List conductors tested on required test data submittal sheet.

ELECTRICAL CONTINUITY AND PHASE ROTATION:

After conductor connectors are installed and conductors are labeled, but before termination to terminals or devices, an electrical continuity test shall be performed on each conductor using a battery powered buzzer or ohmmeter to determine that all power, control, grounding, and other conductors are properly installed and identified. List all conductors tested on required test data submittal sheets.

After initial energizing of the transformer, check for proper phase rotation.

APPENDIX D

OUTLINE SPILL PREVENTION, CONTROL, AND COUNTERMEASURES PLAN

OUTLINE SPILL PREVENTION, CONTROL, AND COUNTERMEASURES PLAN

MINIMUM SPILL PREVENTION REQUIREMENTS

The following shall be performed before the start of and during any fluid removal from a liquid cooled transformer (i.e., PCB filled, oil filled, or silicone filled).

a. A layer of 6 mil polyethylene sheeting shall be placed around the transformer.

b. If drains are present, measures will be taken to eliminate the potential for any fluids from entering the drains. This includes, but is not limited to, constructing a dike, trenching around the drain, and/or plugging the drain.

c. Before pumping the fluids, all hoses shall be inspected for any holes, cracks, or deterioration. Fittings shall be inspected to ensure a proper connection. Any gaskets utilized in the pumping operations shall be inspected for integrity. Approved hoses, pumps, and gaskets shall be used.

d. Drip pans shall be placed under pumps and connections.

e. Pumps and hoses shall be positioned so as to minimize any tripping hazard.

f. Personnel will monitor the pumping operation at all times.

g. An adequate supply of absorbent materials and cleanup equipment shall be readily available in the event of a mishap.

This includes the following, but not limited to:

1. Shovels
2. Brooms
3. DOT drums: 17E, 17H, and 85 gallon recovery drum
4. Ample supply of rags
5. Vermiculite (Speedi-Dry)
6. Absorbent booms and/or absorbent pads
7. Assorted corks, plugs, and emergency seals
8. Material Safety Data Sheets (MSDS).

h. All safety equipment shall be inspected before use.

CONTROL

In the event of a spill or leak, the following procedure shall be implemented:

a. <u>Stop the source of the spill</u>. Below is a list of probable source of spills when working with liquid cooled transformers, and the remedial action to be taken to eliminate the problem.

<u>Source 1. Transformer</u>

1. Location of leaks: valves. Remedial action: plug valve to reduce or stop spill. Pump fluid below valve and replace faulty valve.

2. Location of leak: bushing. Remedial action: Pump fluid below bushing level. Replace gaskets, or if necessary, replace bushing.

3. Location of leak: tank wall or radiator pipe. Remedial action: pump fluid below level of leak and either epoxy or weld close the leak source. If the source of the leak is small, a vacuum can be pulled on the transformer before applying the epoxy sealant r welding. Pulling a vacuum on the transformer eliminates the need for any pumping operations.

4. Location of leak: tap changer, liquid level gauge, or temperature gauge. Remedial action: remove fluid below level and replace packing material, gaskets, or thread sealant where applicable.

Source 2. Pumps or Hoses

Remedial action: Stop all pumping operations and place apparatus into an adequate container to capture any fluids.

Source 3. Drums

Remedial action: In the event that the drum is seeping at the seams, the fluid shall immediately be transferred to another drum. Should a drum rupture or become punctured, an oversized recovery drum will be used. The recovery drum is placed over the top of the leaking drum. Then, the recovery drum is placed upright, containing the leaking drum.

b. Stop the migration of any spilled fluid. This can be done by placing the berm around perimeter of the spill. A berm can be constructed using any type of absorbent material, i.e., vermiculite (Speedi-Dry), sand, rags, absorbent boom or pads.

c. Solidify any free standing fluid.

d. Safety apparel shall be worn when dealing with spills involving PCB fluids.

COUNTERMEASURES

The countermeasure operations are the cleanup and disposal of all contaminated material that is a result of the spill. The primary goal of all cleanup activity is to maintain a safe environment.

a. Cleanup

1. Fluids: If the volume of fluids is great enough to where solidification is impractical, the liquid shall be pumped into DOT 17E drums. These drums must be properly labeled and dated.

2. Solids: Any porous solids (soils, asphalt, wood, paper, etc.) contaminated by the spill shall be placed into DOT 17H (removal head) drums. These drums must be properly labeled and dated.

3. Major Spills: In the event that the spill exceeds the control and cleanup capabilities that are onsite, an outside contractor, who specializes in environmental cleanup and has all permits and licenses required, must be contacted. This contractor must be equipped to handle various types of spills.

Analysis. During the cleanup operations, sampling, and analysis must be performed. The analytical data are needed to present an accurate picture of the following:

1. The extent of the spill

2. The effectiveness of the cleanup operations

3. The point in time when the environment has been decontaminated.

5. Disposal. The disposal of all contaminated materials must be in accordance with the applicable EPA regulations (40 CFR 761).

All work will be inspected by the EG&G Idaho, Inc. representative.

Transportation of hazardous waste to the disposal site shall conform to 40 CFR, Part 263. All Federal, state, and local permits and labeling and approvals shall be completed before the shipment of waste from the transformer site.

APPENDIX E

SWITCHGEAR SPECIFICATION

SWITCHGEAR SPECIFICATION

1.0 GENERAL

Provide and install switchgear with the transformer as referenced in the data sheets. The switchgear shall consist of one or more enclosed vertical sections joined together to form a rigid, free standing assembly. The construction of the switchgear shall meet the requirements of the NEC.

2.0 PRODUCTS

600 Volt: Switchgear shall be suitable for operation for 480 volt, 3 phase, 3 wire, 60 Hertz grounded service.

Vertical Sections: Vertical sections shall support the horizontal and vertical buses, covers, and doors, and shall be designed to allow for easy rearrangement of units. Vertical sections shall have structural supporting members formed of a minimum of 13 gauge hot-rolled steel. All finished surfaces shall be blemish-free. Each section shall be 90 inches high and shall have 7 gauge steel, 3 inches high, removable lifting angle and two 1-1/2 inches high base channels. Complete control center lineups shall be divided into shipping splits no wider than approximately 60 inches. A lifting angle shall be provided on the top of each shipping split and shall extend the entire width of the shipping split. Lifting angles shall be designed to support the entire weight of the switchgear and shall have access points or lifting eyes to facilitate handling. Base channels shall be provided with holes to permit bolting the switchgear to the floor. The entire assembly shall be constructed and packaged to withstand all stresses induced in transit and during installation. Switchgear shall be designed so that matching vertical sections of the same current rating and manufacture can be added later at either end of the lineup without use of transition sections and without difficulty. Removable end closing plates shall be provided to close off openings on the end of the lineup. A removable top plate shall be provided on each vertical section and shall be of one piece construction for added convenience in cutting conduit holes. The design shall allow use of the standard conduit entrance area without significant sag or deformation of the top plate.

Vertical sections shall be designed to accommodate plug-on units in front-of-board construction. Vertical sections housing plug-on units shall be 15 inches deep.

Vertical sections shall be provided with both horizontal and vertical wireways. Sufficient clearances shall be provided in the horizontal wireway so that no restriction is encountered in running wires from the vertical to horizontal wireway. Wireways shall be in accordance with the wireways section contained in this document.

Horizontal Wireways: Horizontal wireways shall be provided in the top and bottom of each vertical section and shall be arranged to provide full length continuity throughout the entire assembly. The top horizontal wireway shall have a cross sectional area of not less than 20 square inches with openings between sections of not less than 11-1/2 square inches. The bottom horizontal wireway shall extend through the length and depth of the 11-1/2 square inches to allow for full length continuity throughout the entire assembly. The bottom horizontal wireway height shall be not less than 9-1/4 inches. Covers for all wireways shall be equipped with captive type screws to prevent loss of hardware during installation. All wireways shall be isolated from the bus bars.

Vertical Wireways: A vertical wire trough shall be located on the right-hand side of each vertical section and shall extend from the top horizontal wireway to the bottom of the available unit mounting space. Each vertical wire trough shall have a cross-sectional area of not less than 19 square inches and shall be isolated from the bus bars to guard against accidental contact. A separately hinged door having captive type screws shall cover the vertical wire trough to provide easy access to control wiring without disturbing the unit.

Reusable wire ties shall be furnished in each vertical wire trough for the purpose of grouping and securely holding wires in place for a neat and orderly installation.

Bus Bars: A continuous main 3-conductor horizontal bus shall be provided over the full length of the switchgear. When necessary, the bus shall be split to allow for ease in moving and handling. Splice bars will be supplied to join the bus whenever a split has been made. All splice connections shall be made with at least 2 bolts. Horizontal busbars shall be mounted edgewise and supported by insulated bus supports. Insulation shall be used as required by NEMA standards and shall be dated at no less than 600 VAC.

For distribution of power from the main horizontal bus to each unit compartment, a 3-phase vertical bus shall be provided. The vertical bus shall be firmly bolted to the horizontal bus for permanent contact.

The main horizontal and vertical buses shall be made of copper and the entire length shall be electrolytically tin plated to provide maximum protection to the bus bars from normal or adverse atmospheric conditions.

The main horizontal bus rating shall be a minimum 800 amperes continuous. Vertical bus rating shall be a minimum of 300 amperes for adequate current carrying capacity. Continuous current ratings shall be in accordance with temperature rise specifications set forth by UL, ANSI, and NEMA standards.

A copper ground lug shall be provided in each incoming line vertical section capable of accepting No.8 to 350 MCM cable. A horizontal (and vertical) tin plated copper ground bus shall be provided in each section of the switchgear. Horizontal ground bus shall run continuously throughout the switchgear except where splits are necessary for ease of shipment and handling in which case splice bars shall be provided. Ground bus shall be tin plated copper. Horizontal ground bus shall be located at

the bottom of the switchgear. Vertical ground bus shall run parallel to the power distribution bus in each vertical section. Design shall be such that for any plug-on unit the ground bus stab shall make contact with the ground bus before the power bus contact is made.

Bus Barriers: Insulated horizontal and vertical bus barriers shall be furnished to reduce the hazard of accidental contact with the bus. Barriers shall have a red color to indicate proximity of energized buses. Vertical bus barriers shall have interlocking front and back pieces to give added protection on all sides and shall segregate the phases to reduce the possibility of accidental "flash over." Small, separate openings in the vertical bus barriers shall permit unit plug-on contacts to pass through and engage the vertical bus bars. Bottom bus covers shall be provided below the vertical bus to protect the ends of the bus from accidental contact with fish tapes or other items entering from the bottom of the enclosure.

Controls and Meters: All new service panels shall be equipped with the following:

Kilowatt Meters. Type II, Class 3, Style B and shall have provisions for pulse inititation. Kilowatt meters shall be flush switchboard type as indicated on the drawings and shall be totally compatible to each particular application. Kilowatt meters shall be of one manufacturer, secondary type.

- The meters shall have an electronic demand register. The register shall be used to indicate maximum kilowatt demand as well as cumulative basis. It shall have provisions to be programmed to calculate demand on a rolling interval basis.

- The register shall be of modular design. The electronic module, containing all the program variables, shall be able to be easily removed from the mechanical register for programming, maintenance and trouble shooting.

the bottom of the switchgear. Vertical ground bus shall run parallel to the power distribution bus in each vertical section. Design shall be such that for any plug-on unit the ground bus stab shall make contact with the ground bus before the power bus contact is made.

Bus Barriers: Insulated horizontal and vertical bus barriers shall be furnished to reduce the hazard of accidental contact with the bus. Barriers shall have a red color to indicate proximity of energized buses. Vertical bus barriers shall have interlocking front and back pieces to give added protection on all sides and shall segregate the phases to reduce the possibility of accidental "flash over." Small, separate openings in the vertical bus barriers shall permit unit plug-on contacts to pass through and engage the vertical bus bars. Bottom bus covers shall be provided below the vertical bus to protect the ends of the bus from accidental contact with fish tapes or other items entering from the bottom of the enclosure.

Controls and Meters: All new service panels shall be equipped with the following:

Kilowatt Meters. Type II, Class 3, Style B and shall have provisions for pulse inititation. Kilowatt meters shall be flush switchboard type as indicated on the drawings and shall be totally compatible to each particular application. Kilowatt meters shall be of one manufacturer, secondary type.

- The meters shall have an electronic demand register. The register shall be used to indicate maximum kilowatt demand as well as cumulative basis. It shall have provisions to be programmed to calculate demand on a rolling interval basis.

- The register shall be of modular design. The electronic module, containing all the program variables, shall be able to be easily removed from the mechanical register for programming, maintenance and trouble shooting.

- All electronic modules shall be physically identical and interchangeable.

- A frictionless optical assembly, mounted directly to the meter frame, generating 12 pulses per meter disc revolution for input to the electronic register shall be provided.

- Each kilowatt meter shall also be complete with a 5-dial mechanical kilowatt hour register.

- Meters shall be 3 stator, 120 volt for use on a wire Y, 3-phase system.

- Meter multiplier shall be shown on the face plate and shall be the product of the indicated current transformer and potential transformer ratio.

- Draw out arrangement for meter removal incorporating automatically short circuit current transformer circuits.

- Meter covers shall be polycarbonate resin.

- Meter detent to prevent negative registration by restricting the backward rotation of the disk.

- The normal billing data scroll shall be fully programmable. The following items shall be displayed in the data scroll:

  - Kilowatt hours
  - Maximum demand
  - Cumulative or continuously cumulative
  - Number of demand resets
  - Time remaining in interval
  - End-of-interval indication
  - New maximum demand indication

- The register shall incorporate a built-in test mode that allows it to be tested without the need for any special tools or other accessories and saves data and constants before start of the test. The following quantities shall be available for display in the test mode:

  - Time remaining in demand interval
  - Present interval's accumulating demand
  - Maximum demand
  - Number of impulses being received by the register

- Pulse initiator with programmable ratio selection.

- Battery with battery port for quick changes.

- Meters shall be programmed after installation.

- Meters shall be tested, calibrated, and certified after installation.

- Self-monitoring to provide for stored data check sum error, ROM and RAM checksum error, battery fault, and unprogrammed register.

- Liquid crystal display, 9 digits, blinking squares confirm register operation.. Large digits for data and smaller digits for display identifier.

- Display operations, programmable sequence with display identifiers. Display identifiers shall be selectable for each item. Continually sequence with time selectable for each item.

Circuit Breakers: Molded e circuit breakers shal be furnished in branch feeder units using c.rcuit breakers as a disconnect means. All circuit breakers will have a push-to-trip test feature for testing and exercising the trip mechanism. Breakers shall be UL listed for a minimum of 22,000 amperes RMS symmetrical fault withstandability.

Main breakers (480 volt panels only) shall be equipped with auxiliary contacts and shunt trip coils. Optional electrical operation mechanisms shall be proposed for possible use if funding levels are adequate.

Identification: A control center identification nameplate with factory identification numbers and characteristics shall be fastened on the vertical wire trough door of every section. Each unit shall have its own identification nameplate fastened to the unit saddle. These nameplates shall have suitable references to factory records for efficient communication with supplier. Each unit shall also have an engraved nameplate fastened to the outside of the unit door for ease in identification and for making changes when regrouping units. Main breakers (480 panels only) shall be equipped with auxiliary monitoring contacts and shall be equipped with short trip controls. Optional electrical operations shall be proposed for possible use if funds are adequate.

Wiring: The switchgear wiring shall be NEMA Class II, Type B.

As defined by NEMA Standard ISC-2-322, Class II switchgear shall include the necessary electrical interlocking and interwiring between units.

Type B wiring shall include terminal blocks mounted on lift out brackets in the units.

Terminal blocks shall be quick separating pull-apart solderless box lug type or equal.

Finish: All metal structural and unit parts shall be completely painted using an electrodeposition process so that the interior and exterior surfaces as well as bolted joints have a complete finish coat on and between them.

3.0 TESTS

3.1 Following tests shall be performed and results recorded. All the equipment tests shall be performed in accordance with IEEE, NEMA, and ANSI Standards where such standards are definitive. All test data including but not limited to test circuitry, faulty equipment, and remedial action will be recorded, certified, correlated, bound, and furnished to the Owner.

a. Wiring continuity - point to point check and verification with the wiring diagrams.

b. Wiring insulation - check to ground - megger at 600 volts.

c. Power of proper amplitude and frequency shall be applied to all AC and DC circuitry. Three-phase potential and current of proper frequency shall be applied to all applicable AC connections.

d. Polarity tests of all AC and DC circuitry. Three-phase power and phase angle meter shall be used to make AC polarity test on power feeds and metering circuits.

e. Functional tests shall be performed on all equipment to indicate proper operation of all protection, metering, and control equipment. Power circuit breaker simulators shall be employed for the primary bus to verify proper operation of all equipment.

f. The Owner may at his option provide specific relay and metering test forms to be complied with, otherwise the Seller shall submit 2 copies of Seller's standard test forms for review by the Engineer.

g. All "as left" test values shall be recorded and shall be within manufacturer's tolerances. Manufacturer's tolerances shall be indicated on the test forms.

h. The intent of the acceptance test is to determine that the meters and relays have not sustained damaged during shipment from the manufacturer and that the meters and relay calibrations have not been disturbed. If the examination or test indicates that re-adjustment is necessary, the relay shall be repaired and/or calibrated as per manufacturer's instructions.

3.2 The Owner and/or Engineer may elect to visit the Seller's facilities on completion of fabrication of the equipment to inspect the equipment and witness testing as outlined in Section 3.1.

EG&G Idaho, Inc.
FORM EG&G-480
(Rev. 01-87)

ES — 51334 Rev. B

DATE — May 4, 1990

SPECIFICATION

FOR

THE PURCHASE AND INSTALLATION OF CAST COIL TRANSFORMERS
AT THE SAN DIEGO NAVAL FACILITY

PROJECT NO.

015341

Approved for Release:

M L Nelson
Engineering Graphics
EG&G Idaho, Inc.

EG&G Idaho, Inc.

FORM EG&G-1034
Rev. 03-85

DOCUMENT APPROVAL SIGNATURE SHEET

Type of Document	Document No.
ENGINEERING SPECIFICATION	ES-51334

Title
SPECIFICATION FOR THE PURCHASE AND INSTALLATION OF CAST COIL TRANSFORMERS AT THE SAN DIEGO NAVAL FACILITY

Prepared By S.A. MCBRIDE — Ext. 9330

Originated By G.D. SEIFERT — Ext. 9522

(PRINT OR TYPE NAME IN SPACE ABOVE SIGNATURE)

Approval and Review Signatures	Organization	Mail Address	Date
J.F. JACOBSEN	INEL - POWER SYSTEMS ENGINEERING	3502	11/20/89
V.E. BERG V E Berg	INEL - Quality Engineering	3568	11-20-89
A.D. HILL	INEL - ELECTRICAL SAFETY	3423	11-20-89
R.J. WHITE	NCEL - EE PROGRAM MANAGER	2302	11/20/89
Revision A per DRR EGG-737 Released by Engineering Graphics on 3-28-90 M L Nelson			
Revision B per DRR EGG-758 Released by Engineering Graphics on 5-4-90 M L Nelson			

CONTENTS

APPENDICES

ES-51334

SPECIFICATION
FOR THE PURCHASE AND INSTALLATION OF
CAST COIL TRANSFORMERS AT THE
SAN DIEGO NAVAL FACILITY

1. SCOPE

1.1 Scope. This specification covers the design, fabrication, testing, installation, and inspection of cast coil, dry-type, power transformers and the removal of existing polychlorinated biphenyl (PCB) transformers, handling of PCB fluid, and obtaining the permits required for hauling hazardous waste. The intent is to make a turnkey replacement with advanced technology transformers including any equipment needed to replace the existing transformers. They will be used to provide the Navy with performance data on these advanced technology devices.

1.2 Applicability. It is not the intent to specify details of design and construction except where necessary to establish performance requirements, nor is it intended to set forth those performance requirements, which are adequately specified in applicable standards.

All components of the transformers shall be new and function in a satisfactory manner within their rated capacity under the specified service conditions regardless of whether all necessary specific performance requirements are set forth herein or in applicable standards.

2. APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent specified herein. The issue of a document and amendments in effect on the date of publication of this specification shall apply.

2.1 American National Standard Institute (ANSI).

ANSI-C57 12.01	General Requirements for Dry-Type Distribution and Power Transformers
ANSI-C57 12.70	Terminal Markings and Connections for Distribution and Power Transformers
ANSI-C57 12.80	Terminology for Power and Distribution Transformers
ANSI-C57 12.91	Test Code for Dry Type Distribution and Power Transformers
ANSI-C57 12.94	Recommended Practice for Installation Application, Operation, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers
ANSI-C57 12.96	Loading Dry-Type Distribution and Power Transformers
ANSI-C57 12.98	Guide for Transformer Impulse Tests
C2-1989	National Electrical Safety Code
Z35.1	Specifications for Accident Prevention Signs

2.2 National Electric Manufacturers Association (NEMA).

NEMA TRI-1974	Transformers, Regulators, and Reactors

2.3 National Fire Protection Association (NFPA) Publication.

NFPA 70	National Electrical Code

2.4 Others.

IEEE 400-1980	IEEE Guide for Making High Direct Voltage Tests on Power Cable Systems in the Field
NEESA 20.2 - 028a	PCB Compliance, Assessment, and Spill Control Guide
OPNAVINST 5090.1	Environmental and Natural Resources Protection Manual
29 CFR	General Industry Safety and Health Standards
40 CFR 263	Standards Applicable to Transporters of Hazardous Waste
40 CFR 761	Polychlorinated Biphenyls (1979)
49 CFR 172	Hazardous Materials Tables and Communications Standards
49 CFR 173	General Requirements for Shipping and Packaging
California CAC Title 22, Division 4	Environmental Health
PWC San Diego	Utility Standards
MIL-P-28641	Primer Coating, Vinyl Chlorine Acetate, Copolymer, High Build (for steel and masonry)
MIL-Q-9858A	Quality Program Requirements

3. TECHNICAL REQUIREMENTS

3.1 General. The transformers shall have low loss metal cores and shall be three phase three-winding, self-cooled, dead front, suitable for installation indoors or outdoors, or as specified in the attached data sheets in

Appendix A. They shall have primary and secondary compartments that shall enclose all termination devices so that no live parts are exposed when the transformer is energized. Unit substation transformer installations are exempt from the dead front requirement. The transformer and installation shall meet all applicable requirements of the ANSI, ASTM, NEC, and NEMA publications as specified herein. The transformer shall be of new construction. The successful bidder shall be responsible for all field modifications, measurements, provide installation and checkout, and turn the transformer over to the operations department, PWC San Diego, through the EG&G Idaho, Inc. Resident Engineer, ready for operation. A

3.2 Electrical Products. All materials, appliances, equipment, or devices shall conform to the applicable standards of the Underwriter's Laboratories, Inc. (UL) and applicable chapters of the National Electrical Code (NFPA 70), where such standards exist. All materials, appliances, equipment, or devices shall be listed and/or labeled by UL, where such standards exist.

3.3 Condition of Products. Except as otherwise indicated, new electrical products free of defects and harmful deterioration shall be provided at the time of installation. Each product provided shall be complete with trim, accessories, finish guards, safety devices, and similar components specified or recognized as integral parts of the product, or required by the governing regulations.

3.4 Uniformity. Where multiple units of a product are required for the electrical work, identical products shall be provided by the same certified and approved manufacturer without variations except for sizes and specific variations as indicated.

3.5 Test Point Observation. The successful bidder shall supply EG&G Idaho with a flow sheet for the manufacture of each transformer indicating all test points. The successful bidder shall notify EG&G Idaho, in writing, of the date that each test will be conducted at least 14 days before that test and will admit EG&G Idaho and government representatives to witness the tests.

3.6 Performance Requirements. Each transformer shall comply with the following performance requirements as specified in ANSI-C57 12.00, except as noted in the data sheet in Appendix A.

Transformer Rating	As specified in Appendix A.
Auxiliary Cooling	Forced air provisions, fan mounts, and temperature sensor access points as a minimum shall be provided for future. Refer to the data sheets in Appendix A for special instructions.
Primary Voltage	As specified in Appendix A. Note special dual voltage requirements.
Primary Connection	As specified in Appendix A.
Frequency and Phase	60 Hertz, 3 Phase
Secondary Voltage	As specified in Appendix A. Note special dual voltage requirements.
Secondary Connection	Wye connection with neutral to be brought out through an insulated bushing with external ground strap.
Temperature Rise	80°C, per NEMA TRI-1974
Taps - No-Load	Minimum of five full capacity high voltage taps (two 2 1/2% taps above and 2 1/2% taps below normal voltage and tap position indicators).

Insulation Levels

Primary Voltage	95 KV BIL for Insulation Class 15 KV and 75 KV BIL for Insulation Class 5 KV. Based on specific voltage ratings, which are in the data sheets in Appendix A.
Secondary Voltage	30 KV BIL for Insulation Class 600 V. For specific voltage ratings, see the data sheets in Appendix A.
Coil Construction	HV and LV windings shall be cast as separate rigid tubular coils and arranged coaxially. Transformers 300kVA and under may be constructed using approved non-tubular connected coils. Each cast coil shall be fully reinforced with fiberglass cloth and tape (or equivalent) and cast under vacuum in a mold to ensure complete, void-free resin impregnation throughout the entire insulation system. Coils shall be supported by cast epoxy bottom supports and spacer blocks (or equivalent) and spring loaded top blocks (or equivalent) and have no rigid mechanical connection. Both primary and secondary windings shall be copper or approved low loss aluminum. Approval is based upon showing optimal loss evaluation cost performance values. A
Impedance	As specified in the data sheets in Appendix A with the following guidelines: 1. The minimum allowable impedance for transformers 750 KVA and above is 4.0 percent. 2. The minimum allowable impedance for transformers 500 KVA is 3.5 percent.

3. The tolerance is +/- 7 1/2 % except for the transformers with dual rated primaries which shall have an impedance tolerance of +/- 10 %. A

No-Load Loss

The no-load losses (core loss) shall be optimized per the evaluation formula provided in the attached bid package/Request for Proposal (RFP).

Load Loss

The load losses (winding losses) shall be optimized per the loss evaluation formula provided in the attached bid package/RFP.

Sound Level

Shall not exceed noise level per NEMA standards.

Core Material (General)

The core shall be assembled with low loss, silicon steel sheets and shall be properly braced and assembled. The specific type of low loss silicon steel is to be determined by the manufacturer to meet the lowest total operating costs and optimize no-load losses. However, the intent of this replacement program is to install advanced technology transformers wherever it is economically feasible. The use of amorphous metal, laser etched steel, or other advanced technology core material is encouraged in order to meet low operating cost criteria.

Core Material (Amorphous)

<u>This section only applies to those devices specified with an amorphous metal core</u>. The transformer shall be constructed of low loss amorphous metal in a wound or stacked core design as designated in the RFP. The complete core assembly shall be fully

encapsulated with a protective coating of approved material to eliminate sharp edges and prevent flaking particles and to protect the core from corrosive products. The no-load loss shall be less than 45% of those for comparable silicon steel core designs. It is known that wound core is standard. However, a few of the options in the data sheets specifically require that stacked core will be treated as a research project to get a "new" technology unit. The other amorphous core devices can be wound (or stacked) at the manufacturer's discretion.

3.7 Environmental Conditions.

Elevation	50 feet above sea level
Location	Indoor/outdoor (See Appendix A.)
Temperature Range	0°C to 40°C

3.8 Accessories. The transformer shall have the following accessories as a minimum. The accessories shall be constructed and located as described in ANSI-C57 12.00.

- Elbow terminators, fuses, and load breaker switches as called out in Section 3.6, primary connection section, and per individual data sheets in Appendix A.
- Dial type thermometer with alarm contact of sufficient capacity to control the future fan contactor and an additional contact for a future utility control system. Thermometer shall monitor the hottest secondary coil phases.
- Tap changer (de-energized operation only).
- Lifting, moving, and jacking provisions.

- Stainless steel/aluminum nameplate with information required in ANSI-C57 12.00 on the transformer exterior. (note: stainless steel is preferred) A

- Ground pads.

- A junction box shall be located on the transformer nameplate and contain a terminal board for all electrical circuits entering or leaving the junction box. The junction box shall have a hinged door with a gasket and a handle with provisions for padlocking. All electrical circuits from components mounted within the transformer shall run to this terminal board.

- An optional coil surface temperature sensing thermocouple shall be mounted in the prevailing transformer thermal hot spot for each secondary phase coil. As a minimum, provisions for adding a future thermocouple shall be provided even if the option for the coil surface temperature sensing thermocouple is not added. Each thermocouple shall be installed such that it will preclude circulating air influence. These three thermocouples will provide input to an electronic temperature monitor. This instrument shall respond to the hottest phase temperature and automatically display this reading. An analog meter shall continuously display the hottest phase temperature and indicate individual phase readings or the maximum temperature reached over a period of time. Light emitting diodes are not acceptable. The highest temperature shall also be used to initiate alarm and trip functions and is stored for future recall until the maximum temperature memory is cleared. Fail safe alarm relay circuits automatically actuate if supply power has been lost. Maximum temperature can be recalled even if supply power has been interrupted. A self-test procedure allows set points to be determined and their operation verified. Alarm and trip set points will be tested from the front panel. Open thermocouple circuits are detected and indicated, but do not affect instrument operation. Manual control of alarm and test functions shall be provided. All input and output connections shall be made to the terminal blocks on the back of the instrument. The set points of this thermal device shall be adjustable, and two sets of alarm and trip contacts shall be provided. The alarm contacts on the temperature indicator shall be factory wired and brought out to the terminal blocks on the exterior of the transformer enclosure. The terminal blocks shall be mounted in the junction box. A thermometer with a remote sensing bulb is not acceptable. The thermocouple shall be removable without disconnecting the electrical wiring. The temperature monitor system shall be graduated in degrees centigrade and shall be tested at 200°C before installing on the transformer. The thermally operated device shall be coordinated with the transformer design and shall be connected and set to function as follows:

- First stage shall be adjustable and set at 140°C temperature at which the substation audible bell alarm is activated.

- Second stage shall be adjustable and set at 155°C temperature at which the transformer is isolated by removing the electric load and tripping all the power circuit breakers via the circuit breakers' shunt trip coils (by others in the future).

3.9 Enclosure Construction. The enclosure shall be constructed of heavy gauge painted sheet steel. All ventilating openings shall be in accordance with NEMA and National Electric Code standards for ventilated enclosures. The base shall be constructed of structural steel members to permit skidding or rolling in any direction. Stainless steel enclosures for outdoor transformers are not required, but optional prices for stainless enclosures are requested.

The core shall be grounded to the frame in accordance with applicable NEMA and ANSI standards.

3.10 Paint. The color of the finished transformer shall be C37.20 Federal Standard 595 dark forest green enamel.

3.11 Miscellaneous Requirements.

3.11.1 Insulated Phase Barriers. Primary or secondary insulated phase barriers shall be provided.

3.11.2 Undercoating. Transformers, which have bases that come in contact with concrete, shall have the underside of their bases coated with a corrosion resistant coating that conforms to Military Specification MIL-P-28641 (or an equivalent) with a minimum thickness of 4 mils.

3.11.3 Warning Signs. In accordance with ANSI Z35.1, warning signs shall be provided for the enclosures of electrical transformers having a nominal voltage rating of 500 volts or above.

3.12 Provisions for Fan Cooling. The transformer, 500 KVA or larger, shall have provisions for future fan cooling (by others). As a minimum, fan mounting brackets and dial thermometers with control contacts shall be provided.

3.13 Testing. The following tests shall be performed in accordance with NEMA TRI, ANSI-C57 12.91, and ASTM Standards as listed by the associated tests. All testing, except the field tests, shall be done at the factory, and the certified results shall be submitted to the buyer for approval before shipment of the transformer. Field tests shall be performed unless specifically denied by EG&G Idaho and shall also have certified test procedures and results if opted by EG&G Idaho. All testing included in this Specification shall be performed and costs must be included in the transformer purchase price. A

The purchaser reserves the right to witness any or all tests, and the vendor shall notify the purchaser 14 days in advance of the date for conducting any test (see Section 3.5).

Field tests shall be conducted by representatives of the manufacturer and shall be completed after the transformer has been set in place and before the primary and secondary connections are made. These tests shall be as described in Section 3.13.2.

The tests below shall be made on each transformer as a minimum requirement. The order of listing does not necessarily indicate the sequence in which the tests shall be conducted.

3.13.1 <u>Factory Electric Tests</u>.

1. Coil resistance measurements of all windings on the rated voltage connection and at the tap extremes.

2. Turns ratio test on the rated voltage connections.

3. Polarity and phase relation tests on the rated voltage connection.

4. No-load loss at rated secondary voltage on the secondary voltage connection.

5. Exciting current at rated voltage on the rated voltage connection.

6. Impedance and load loss at rated current on the rated voltage connection and on tap extremes.

7. Temperature rise tests under conditions specified in ANSI Standards for transformers (typical temperature rise of the "exact" design may be substituted with written approval).

8. Dielectric test.

9. Applied potential test.

10. Induced potential test.

11. Impulse test.

12. Partial discharge test (Note: this test is not covered by ANSI-C57 12.91), test at 1.5 times the rated voltage and 400 Hertz (or equal). If partial discharge does not extinguish by 110% of rated voltage, the transformer shall be rejected. Optional standard factory test methods must be approved by the Resident Engineer before they can be substituted for this test.

3.13.2 Field Tests. Field tests shall be performed as part of installation. Test reports shall be certified for methodology and accuracy.

No-load loss as measured from the secondary winding at ambient temperature (ANSI-C57 12.9). Record both ambient and top oil temperatures. Conduct this test on both the existing transformers to be removed and the new transformers. Record ambient temperatures on the test reports.

Insulation power factor (Method II ANSI-C57 12.90, Section 10.9) Doble Test or equal. (Insulation power factor to be 0.9 or less.)

Before energizing transformer, test transformer turns ratio (TTR) at all tap settings. Megger all leads before connecting them to the transformer and check the leads for grounds using a VOM before any connections are made. Any lead with a Megger reading of less than 10 megohms shall be replaced.

4. QUALITY ASSURANCE PROVISIONS

Unless otherwise specified, the supplier is responsible for all examinations and inspections as specified herein. The vendor shall maintain a Quality Assurance Program in accordance with MIL-Q-9858A or an approved equal during the performance of the contract, which provides adequate quality assurance and control throughout design, fabrication, testing, inspection, and shipping of the transformer. The vendor shall provide the documents describing the Quality Assurance Program and containing the procedures that will be invoked to comply with the above. An Inspection and Test Procedure shall be prepared and submitted to the buyer for approval. Final inspection and test reports as required by this Specification shall be submitted to the buyer for approval. The vendor shall maintain a calibration system for the periodic calibration of test instruments to standards traceable to the National Bureau of Standards.

Vendor data shall be submitted per attached "Vendor Data Requirements List" (see Appendix B).

5. PACKAGING

The transformer shall be prepared for shipment within the Continental United States. All accessories shall be protected from damage. The transformer shall be sealed to prevent entry of moisture or foreign materials during shipment. Documents as indicated in Appendix B shall be required. Shipping is the responsibility of the supplier as part of the total installation package.

6. SUBMITTALS

Within 30 days of receipt of the order, the vendor shall furnish the purchaser all necessary outline drawings and weights of the transformers.

6.1 Shop Drawings and Manufacturer's Data. Shop drawings for transformers shall indicate, but shall not be limited to, the following:

> Overall dimensions, front view, interfaces with existing equipment, and sectional views.
>
> Ratings and sizes of lugs, impedance, taps, and fans.
>
> Manufacturer's published main secondary breaker and feeder devices at each transformer to allow designer to provide settings, which will ensure that proper protection and coordination will be achieved.
>
> Complete list of parts and/or supplies with current unit prices and source of supply.

6.2 Certified Laboratory Test Data. Certified copies of reports of all tests shall be submitted as required.

6.2.1 Transformer Tests. Transformer test shall be performed in accordance with the ANSI-C57 12.91 for dry-type transformers standard test code and Section 3.13. Certified copies of test data for the tests shall be submitted and shall receive approval before delivery of equipment to the pro.ject site. Field test data sheets shall be submitted within 14 days after tes. .ompletion.

7. DEMOLITION AND CONSTRUCTION

7.1 Demolition and Construction General Requirements. The vendor shall furnish technical personnel to be present at the site to perform, as a minimum, the following tasks (see Appendix C). Permits for PCB fluid and transformer casing transport shall be obtained by the successful bidder before removal. Note that OSHA regulations require workers handling PCBs to be properly trained and certified.

Request and have the operating Contractor (PWC personnel) de-energize the existing transformers.

Test the existing transformers for no-load loss, record data, and submit in writing to the Resident Engineer.

Drain the PCB fluid from each transformer into approved drums, seal, and deliver it to the interim hazardous waste storage area at the base.

Purge the transformer case with dry nitrogen gas and seal.

Remove anc liver the transformers to the interim hazardous waste storage are. at the ba e as designated by the Resident Engineer.

Provide and install new transformers and test per Section 3.13.2.

Request PWC personnel to energize the system.

Verify proper operation and turn the operating transformer over to EG&G Idaho for remanding to PWC San Diego.

The EG&G Idaho's Resident Engineer shall coordinate all outages and provide interface between the successful bidders, installers, and the operating

Contractor (PWC). PWC Code 640 is responsible for manifesting all PCB (hazardous waste) activity, and PWC shall be contacted though the EG&G Idaho Resident Engineer.

7.2 Draining. Service shall include removal, packaging, and transporting [to a Defense Reutilization and Maintenance Organization (DRMO) hazardous waste staging area] of the PCB or PCB contaminated fluid initially drained from the transformers. DRMO waste shall be clearly labeled with the contents, level of contamination, its source, and manifested by PWC Code 640.

The Subcontractor must review and comply with the minimum Outline Spill Prevention, Control, and Countermeasures (SPCC) Plan procedure before draining fluid from a PCB transformer (see Appendix D). Appendix D details the SPCC requirements that the Subcontractor must observe.

7.3 Transportation and Disposal. All hazardous waste material shall, as a minimum, be contained in Department of Transportation (DOT) approved containers from point of removal until delivered to final disposal site. The following are methods of handling wastes and are subject to the requirements of 40 CFR, Part 263 and 49 CFR, Parts 172 and 173 and shall be superseded if the regulations are amended.

1. Drums shall be DOT approved for hazardous waste: 17E for fluids, 17H for porous solids, and 17H for rags and solvent.

2. Bulk containers shall be six sided, welded steel construction, lined with a minimum of 10 mil plastic sheet, and watertight. The container shall be handled by a truck specially fitted to transport the container from generation point to disposal point.

APPENDIX A

TRANSFORMER DATA SHEETS

ES-51334

TRANSFORMER DATA SHEET

Transformer Identification	(PWC69-OLD) CC69-NEW *
Location	BLDG 94 OUTDOORS
Size	750/1000 KVA **
Primary Voltage	2.4/12 KV DUAL ***
Primary Winding Type	DELTA
Secondary Voltage	480 V
Secondary Winding Type	WYE-GROUNDED
Percent Impedance	5 %
Primary Switch	NEW 3 POLE 15 KV 600 AF/300 AT FUSED SWITCH
Primary Connection	PROVIDE TRANSITION CUBICLE TO NEW SWITCH
Secondary Connections	PROVIDE NEW COPPER BUS CONNECTIONS TO NEW SECONDARY SWITCHGEAR. PROVIDE AND INSTALL NEW SECONDARY SWITCHGEAR PER SKETCHES. (SEE APPENDIX E OF THIS DOCUMENT.)
Secondary Breaker	PROVIDE AND INSTALL NEW SWITCHGEAR PER ATTACHED SKETCHES
Maximum No-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP
Maximum Full-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP

* This is a replacement of transformer PWC #69, an existing 500 KVA 3 phase 480 V PCB transformer.

** Supply fan to achieve higher rating.

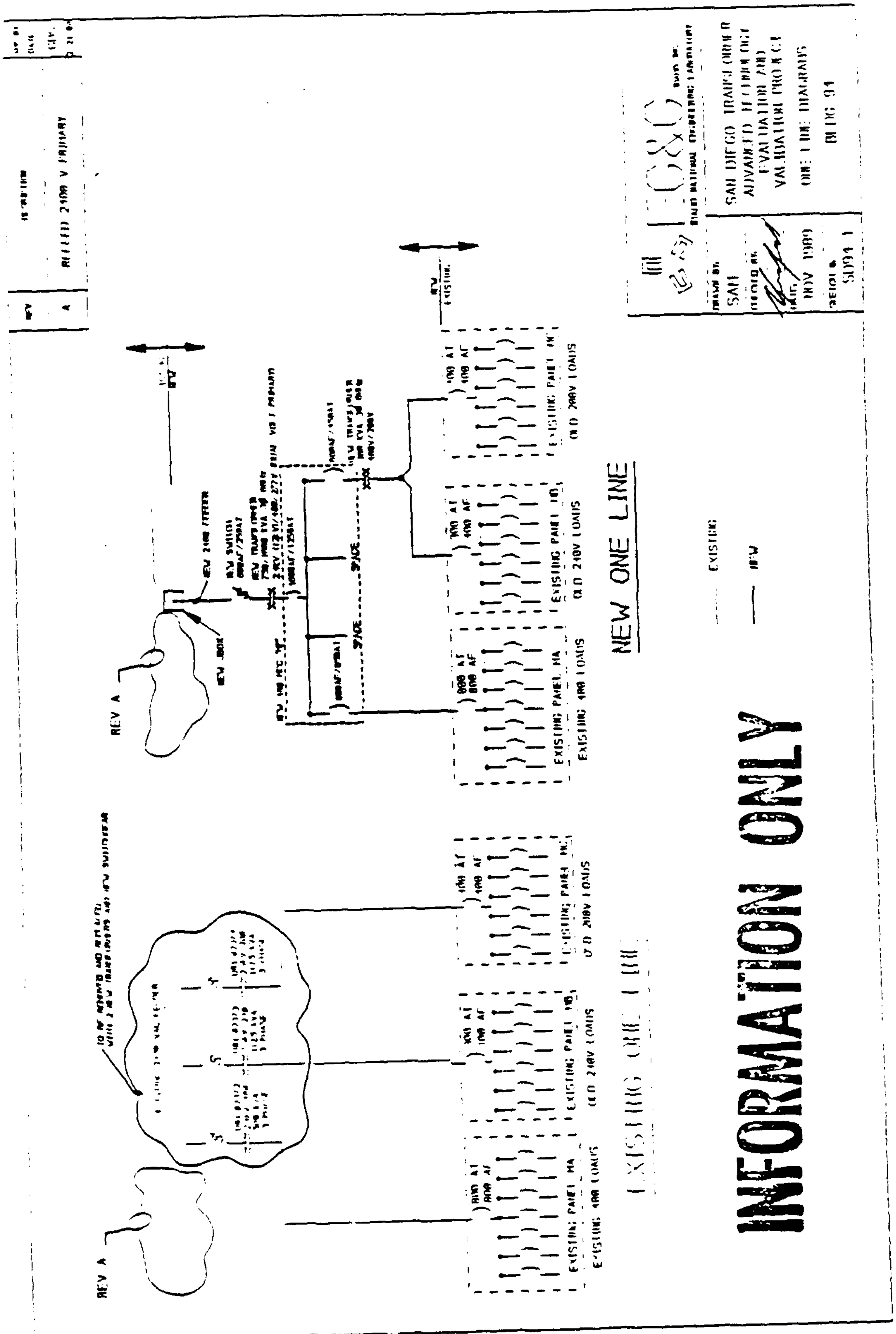
*** Dual voltage primary winding is an option. Regardless of whether the option is exercised, the 2400 VAC primary must be supplied. If the option is exercised then taps shall be provided for the higher rating (12 KV). A

ES-51334

TRANSFORMER DATA SHEET

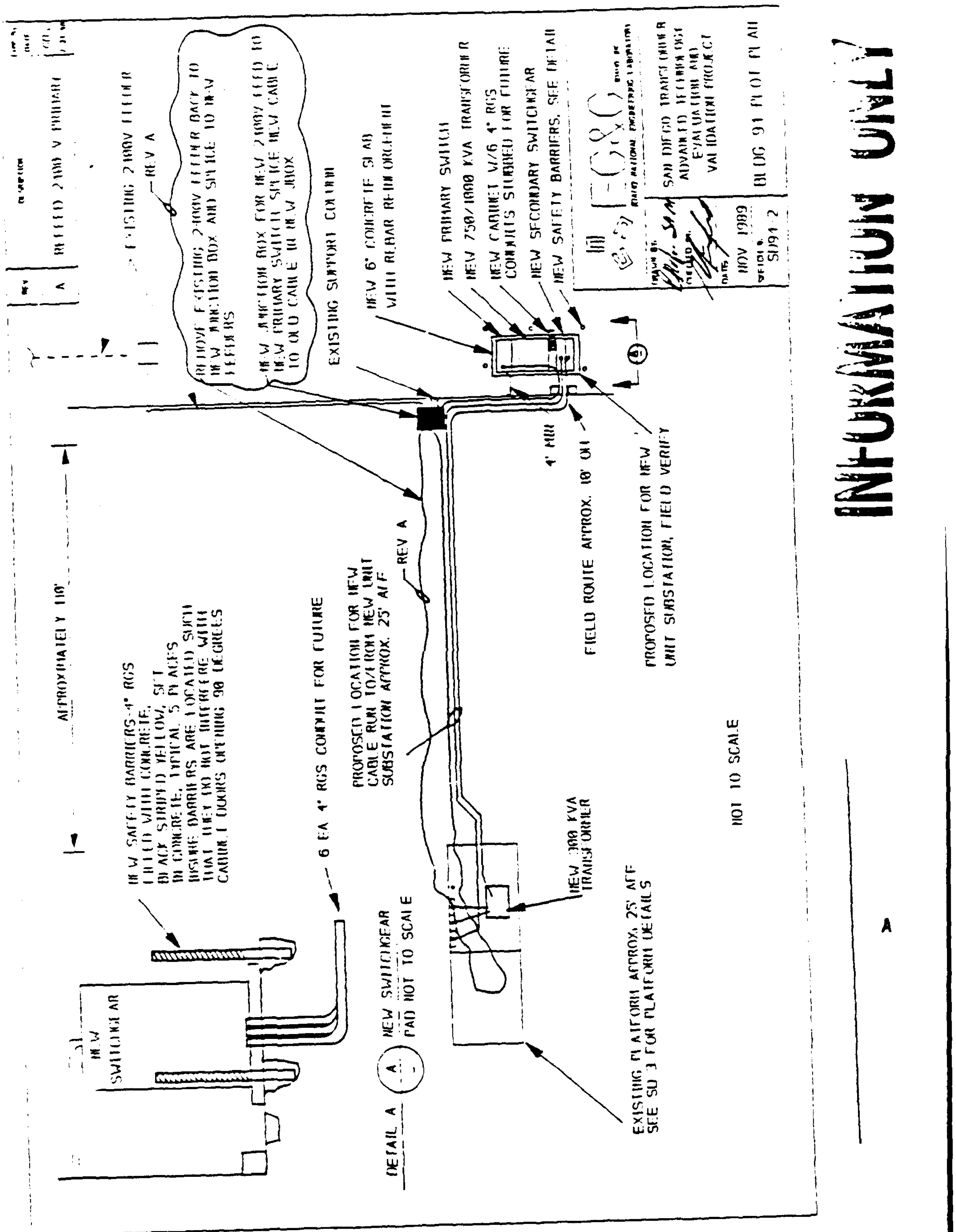
Transformer Identification	(PWC70-OLD) CC70-NEW *
Location	BLDG 94
Size	300 KVA
Primary Voltage	480 V
Primary Winding Type	DELTA
Secondary Voltage	208/120 V
Secondary Winding Type	WYE-GROUNDED
Percent Impedance	3.0
Primary Switch	N/A
Primary Connection	NEW FEED FROM NEW SWITCHGEAR (SEE CC69)
Secondary Connections	NEW CABLE AND CONDUIT CONNECTIONS TO EXISTING SWITCHGEAR (2 places)
Secondary Breaker	EXISTING BREAKER PER ATTACHED SKETCH
Maximum No-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP
Maximum Full-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP

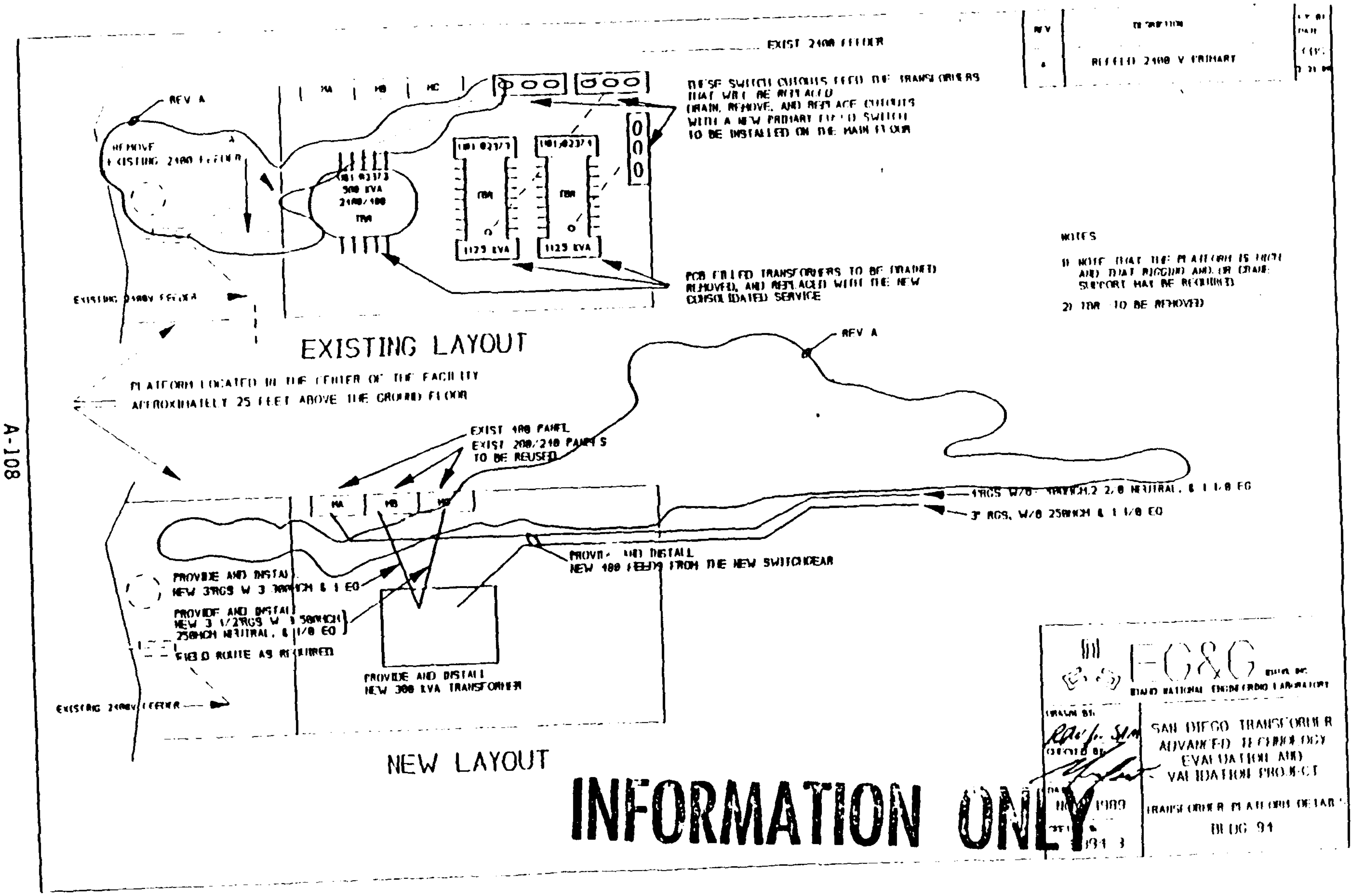
* Consolidation replacement of existing PCB transformers (#70 and #71). See sketches SD 1, 2, and 3 for additional information.



REV A
NEW JBOX
NEW 2400 FEEDER
SPACE
SPACE
EXISTING PANEL MA
EXISTING 480 LOADS
EXISTING PANEL MB
OLD 208V LOADS
EXISTING PANEL MC
OLD 208V LOADS
EXISTING PANEL MA
EXISTING 480 LOADS
EXISTING PANEL MB
OLD 208V LOADS
EXISTING PANEL MC
OLD 208V LOADS
NEW ONE LINE
EXISTING ONE LINE
EXISTING
NEW
INFORMATION ONLY
SAN DIEGO TRAFFIC ORDER
ADVANCED TECHNOLOGY
EVALUATION AND
VALIDATION PROJECT
ONE LINE DIAGRAMS
BLDG 91
NOV 1989

A


REV A
EXISTING 2400V FEEDER
REMOVE EXISTING 2400V FEEDER BACK TO NEW JUNCTION BOX AND SPLICE TO NEW FEEDERS
NEW JUNCTION BOX FOR NEW 2400V FEED TO NEW PRIMARY SWITCH SPLICE NEW CABLE TO OLD CABLE IN NEW JBOX
EXISTING SUPPORT COLUMN
NEW 6" CONCRETE SLAB WITH REBAR REINFORCEMENT
NEW PRIMARY SWITCH
NEW 750/1000 KVA TRANSFORMER
NEW CABINET W/6 4" RGS CONDUITS STUBBED FOR FUTURE
NEW SECONDARY SWITCHGEAR
NEW SAFETY BARRIERS, SEE DETAIL
EG&G IDAHO NATIONAL ENGINEERING LABORATORY
SAN DIEGO TRANSFORMER ADVANCED TECHNOLOGY EVALUATION AND VALIDATION PROJECT
BLDG 91 PLOT PLAN
NOV 1989
SU91-2
APPROXIMATELY 110'
NEW SAFETY BARRIERS-4" RGS FILLED WITH CONCRETE, BLACK STRIPED YELLOW, SET IN CONCRETE, TYPICAL 5 PLACES. INSURE BARRIERS ARE LOCATED SUCH THAT THEY DO NOT INTERFERE WITH CABINET DOORS OPENING 90 DEGREES
6 EA 4" RGS CONDUIT FOR FUTURE
PROPOSED LOCATION FOR NEW CABLE RUN TO/FROM NEW UNIT SUBSTATION APPROX. 25' AFF
REV A
4' MIN
FIELD ROUTE APPROX. 10' OH
PROPOSED LOCATION FOR NEW UNIT SUBSTATION, FIELD VERIFY
NOT TO SCALE
NEW 300 KVA TRANSFORMER
EXISTING PLATFORM APPROX. 25' AFF SEE SU 3 FOR PLATFORM DETAILS
NEW SWITCHGEAR
DETAIL A
NEW SWITCHGEAR PAD NOT TO SCALE
INFORMATION ONLY
A



EXIST 2400 FEEDER
REV
DESCRIPTION
A
REFEED 2400 V PRIMARY
REV A
REMOVE EXISTING 2400 FEEDER
MA
MB
MC
300 KVA
2400/480
TBA
1125 KVA
THESE SWITCH CUTOUTS FEED THE TRANSFORMERS THAT WILL BE REPLACED
DRAIN, REMOVE, AND REPLACE CUTOUTS WITH A NEW PRIMARY FUSED SWITCH TO BE INSTALLED ON THE MAIN FLOOR
PCB FILLED TRANSFORMERS TO BE DRAINED, REMOVED, AND REPLACED WITH THE NEW CONSOLIDATED SERVICE
NOTES
1) NOTE THAT THE PLATFORM IS HIGH AND THAT RIGGING AND/OR CRANE SUPPORT MAY BE REQUIRED
2) TBA TO BE REMOVED
EXISTING 2400V FEEDER
EXISTING LAYOUT
PLATFORM LOCATED IN THE CENTER OF THE FACILITY APPROXIMATELY 25 FEET ABOVE THE GROUND FLOOR
EXIST 480 PANEL
EXIST 208/240 PANELS TO BE REUSED
3" RGS, W/8 250MCM & 1 1/0 EQ
PROVIDE AND INSTALL NEW 480 FEEDS FROM THE NEW SWITCHGEAR
PROVIDE AND INSTALL NEW 3"RGS W 3 300MCM & 1 EQ
PROVIDE AND INSTALL NEW 3 1/2"RGS W 3 500MCM 250MCM NEUTRAL, & 1/0 EQ
FIELD ROUTE AS REQUIRED
PROVIDE AND INSTALL NEW 300 KVA TRANSFORMER
EXISTING 2400V FEEDER
NEW LAYOUT
EG&G IDAHO, INC.
IDAHO NATIONAL ENGINEERING LABORATORY
DRAWN BY
CHECKED BY
SAN DIEGO TRANSFORMER ADVANCED TECHNOLOGY EVALUATION AND VALIDATION PROJECT
TRANSFORMER PLATFORM DETAILS
BLDG 94
INFORMATION ONLY

ES-51334

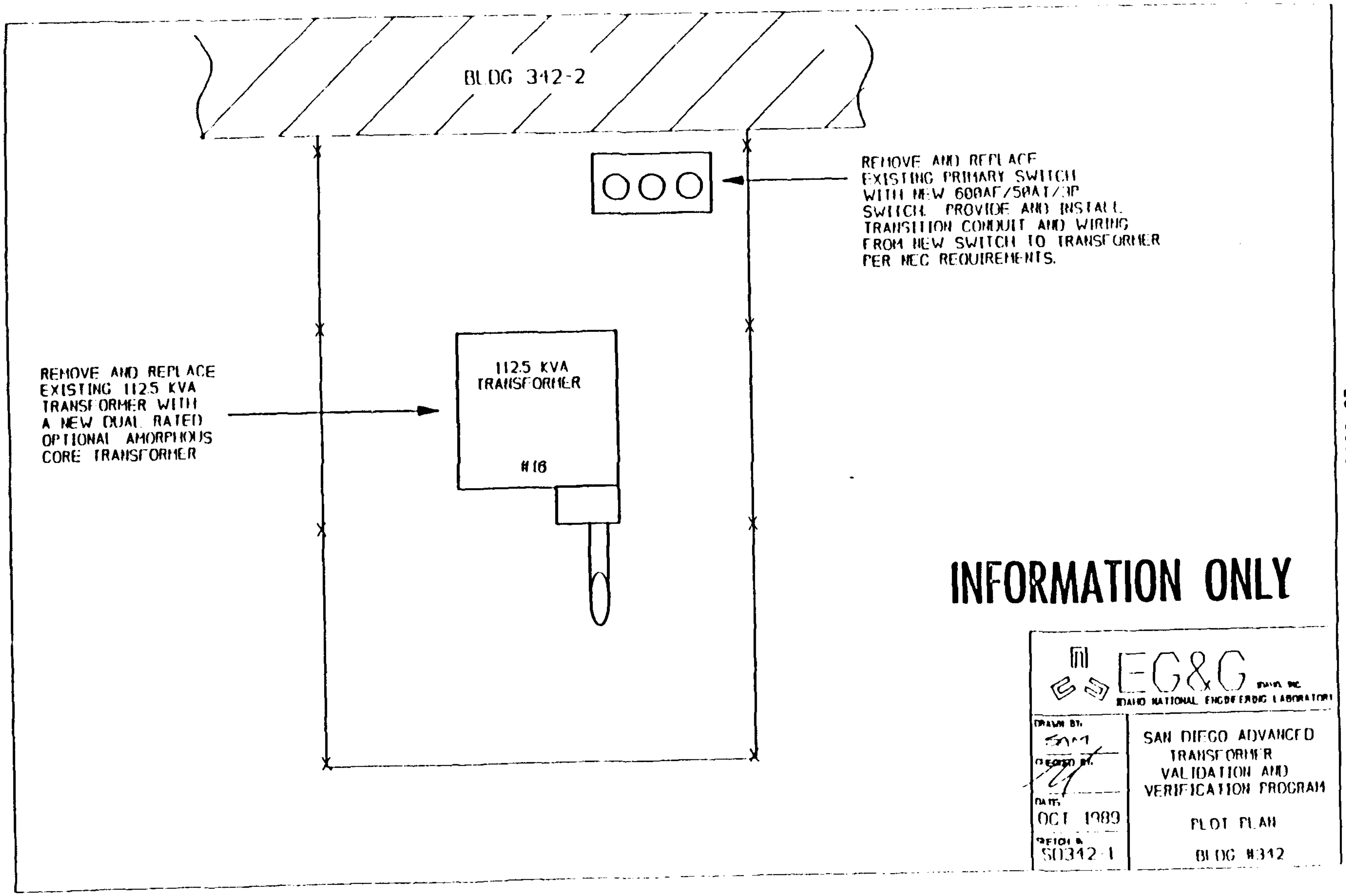
TRANSFORMER DATA SHEET

Transformer Identification	(PWC16-OLD) CC16-NEW *
Location	BLDG 342
Size	112.5 KVA **
Primary Voltage	2.4/12 KV DUAL ***
Primary Winding Type	DELTA
Secondary Voltage	480/277 V
Secondary Winding Type	WYE-GROUNDED
Percent Impedance	3.0
Primary Switch	NEW 3 POLE 15KV 50AF FUSED
Primary Connection	TRANSITION AND CABLE TO NEW SWITCH
Secondary Connections	REUSE EXISTING --- SPLICE TERMINATION FOR CONNECTIONS TO EXISTING SWITCHGEAR
Secondary Breaker	REUSE EXISTING BREAKER -NO CHANGES
Maximum No-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP
Maximum Full-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP

* Replacement of existing 112.5 KVA PCB transformer.

** Optionally propose and construct this unit with an amorphous stacked core, as per specification.

*** Dual voltage primary winding is an option. Regardless of whether the option is exercised, the 2400 VAC primary must be supplied. If the option is exercised then taps shall be provided for the higher rating (12 KV). A

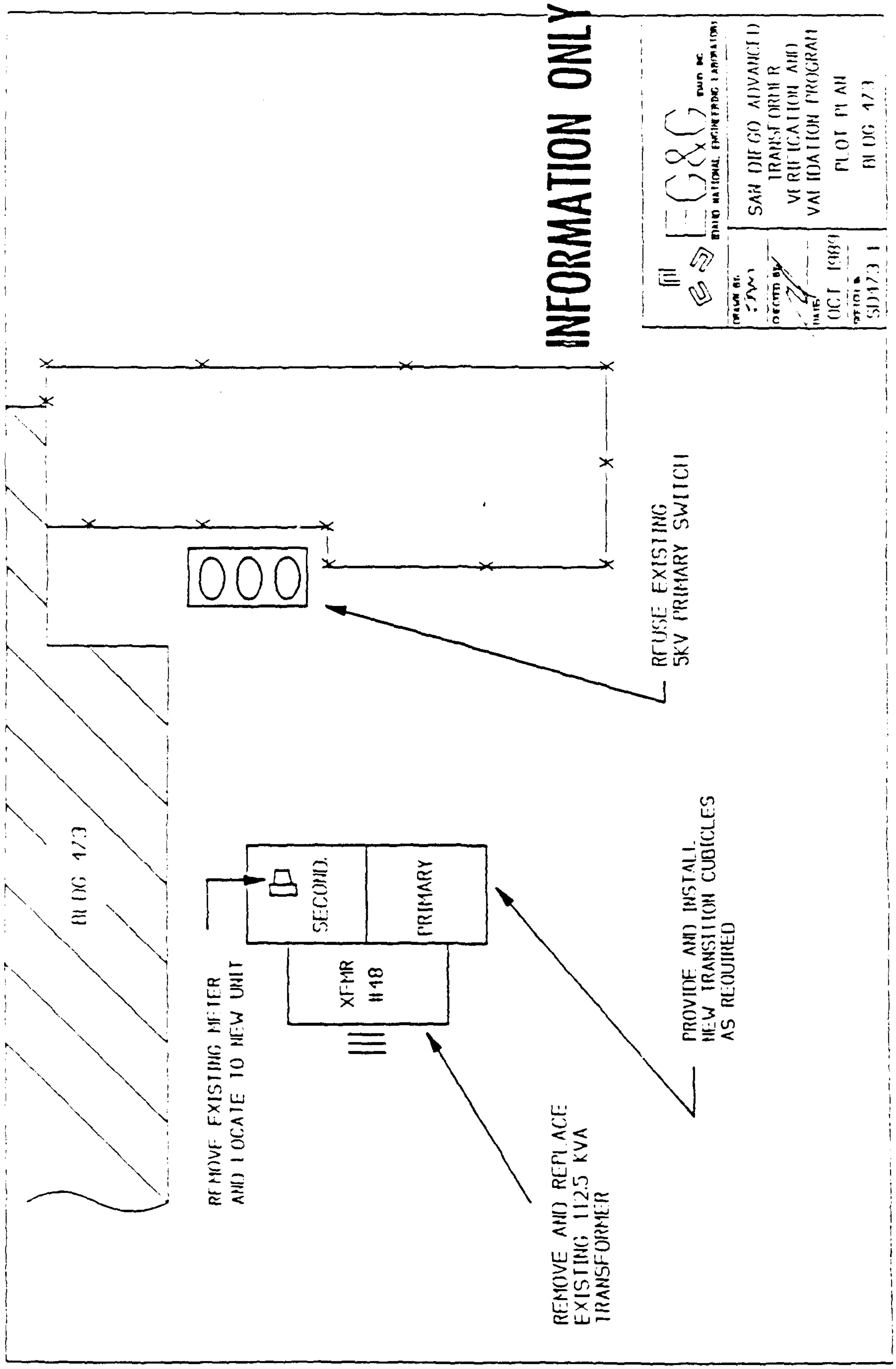

BLDG 342-2
REMOVE AND REPLACE EXISTING PRIMARY SWITCH WITH NEW 600AF/50AT/3P SWITCH. PROVIDE AND INSTALL TRANSITION CONDUIT AND WIRING FROM NEW SWITCH TO TRANSFORMER PER NEC REQUIREMENTS.
112.5 KVA TRANSFORMER
#16
REMOVE AND REPLACE EXISTING 112.5 KVA TRANSFORMER WITH A NEW DUAL RATED OPTIONAL AMORPHOUS CORE TRANSFORMER
INFORMATION ONLY
EG&G IDAHO, INC.
IDAHO NATIONAL ENGINEERING LABORATORY
DRAWN BY:
CHECKED BY:
DATE:
OCT 1989
SD342-1
SAN DIEGO ADVANCED TRANSFORMER VALIDATION AND VERIFICATION PROGRAM
PLOT PLAN
BLDG #342

ES-51334

TRANSFORMER DATA SHEET

Transformer Identification	(PWC48-OLD) CC48-NEW *
Location	BLDG 473
Size	112.5 KVA
Primary Voltage	2.4 KV
Primary Winding Type	DELTA
Secondary Voltage	208/120
Secondary Winding Type	WYE-GROUNDED
Percent Impedance	3.0
Primary Switch	REUSE EXISTING SWITCH
Primary Connection	NEW TRANSITION TO EXISTING SWITCH
Secondary Connections	PROVIDE AND INSTALL NEW SECONDARY TRANSITION CUBICLE
Secondary Breaker	REUSE EXISTING SWITCHGEAR
Maximum No-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP
Maximum Full-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP

* Replacement of existing PCB transformer.

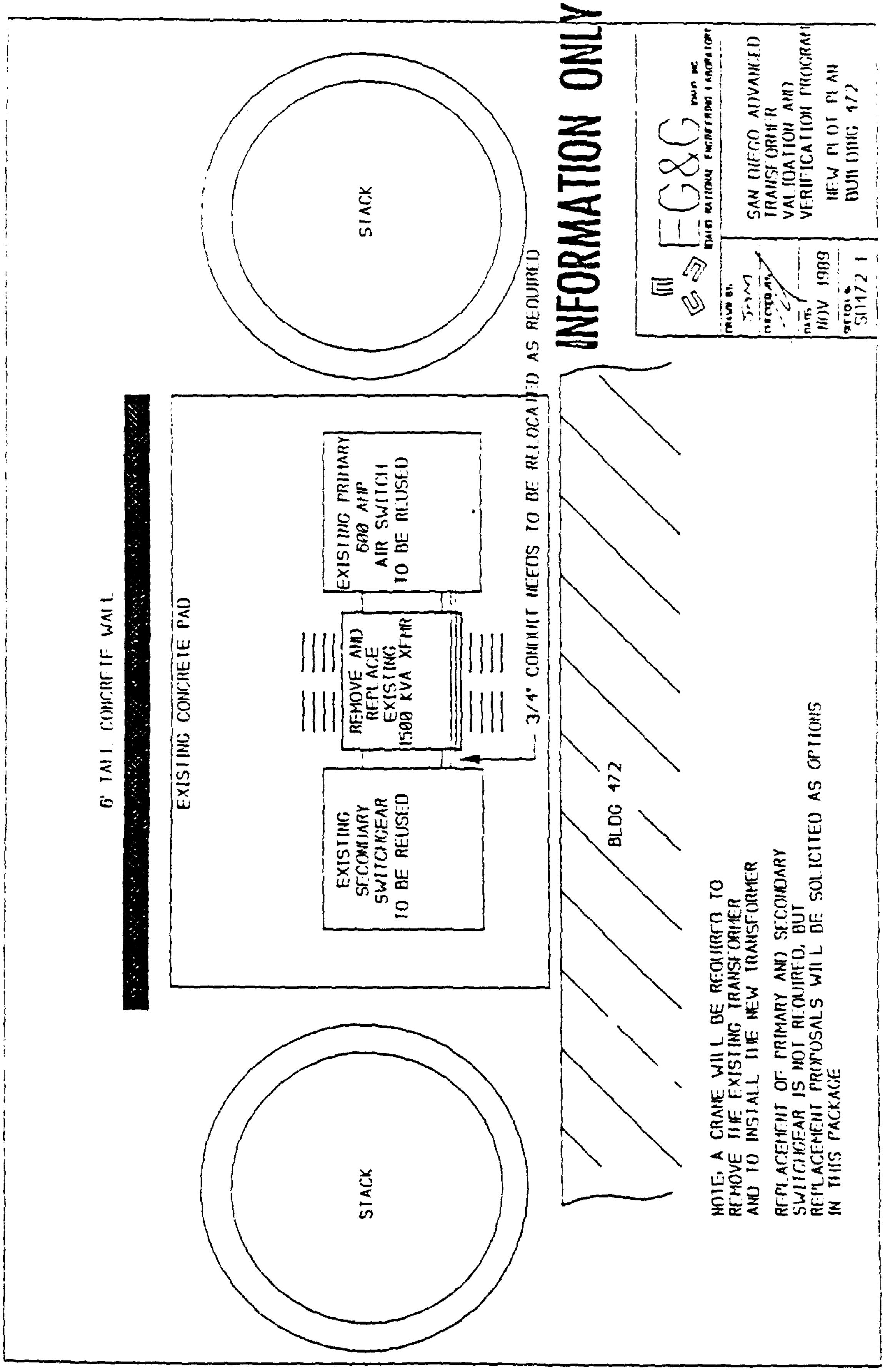

INFORMATION ONLY
SAN DIEGO ADVANCED TRANSFORMER VERIFICATION AND VALIDATION PROGRAM
PLOT PLAN
BLDG 473
OCT 1989
REFUSE EXISTING 5KV PRIMARY SWITCH
SECOND.
PRIMARY
XFMR #48
BLDG 473
PROVIDE AND INSTALL NEW TRANSITION CUBICLES AS REQUIRED
REMOVE EXISTING METER AND LOCATE TO NEW UNIT
REMOVE AND REPLACE EXISTING 112.5 KVA TRANSFORMER

ES-51334

TRANSFORMER DATA SHEET

Transformer Identification	(PWC45-OLD) CC45-NEW *
Location	BLDG 472 OUTDOORS **
Size	1500 KVA
Primary Voltage	12 KV
Primary Winding Type	DELTA
Secondary Voltage	480/277 V
Secondary Winding Type	WYE-GROUNDED
Percent Impedance	5.75
Primary Switch	REUSE OF EXISTING SWITCH ***
Primary connection	NEW TRANSITION TO EXISTING SWITCH
Secondary Connections	COPPER BUS CONNECTIONS TO NEW SWITCHGEAR
Secondary Breaker	REUSE EXISTING BREAKER AND SWITCH-GEAR ***
Maximum No-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP
Maximum Full-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP

* This will replace existing PCB 1500 KVA transformer.
** Use corrosion resistant external packaging, NEMA 3R minimum. Also provide optional ccst to include stainless steel rain cap.
*** Include cost proposal to replace these switches as an option.



INFORMATION ONLY
EG&G IDAHO INC
IDAHO NATIONAL ENGINEERING LABORATORY
SAN DIEGO ADVANCED TRANSFORMER VALIDATION AND VERIFICATION PROGRAM
NEW PLOT PLAN BUILDING 472
NOV 1989
STACK
6' TALL CONCRETE WALL
EXISTING CONCRETE PAD
EXISTING PRIMARY 600 AMP AIR SWITCH TO BE REUSED
REMOVE AND REPLACE EXISTING 1500 KVA XFMR
EXISTING SECONDARY SWITCHGEAR TO BE REUSED
3/4" CONDUIT NEEDS TO BE RELOCATED AS REQUIRED
BLDG 472
STACK
NOTE: A CRANE WILL BE REQUIRED TO REMOVE THE EXISTING TRANSFORMER AND TO INSTALL THE NEW TRANSFORMER
REPLACEMENT OF PRIMARY AND SECONDARY SWITCHGEAR IS NOT REQUIRED, BUT REPLACEMENT PROPOSALS WILL BE SOLICITED AS OPTIONS IN THIS PACKAGE

TRANSFORMER DATA SHEET

Transformer Identification	(PWC26-OLD) CC26-NEW *
Location	BLDG 378-6 OUTDOOR
Size	500 KVA
Primary Voltage	12 KV
Primary Winding Type	DELTA
Secondary Voltage	480/277 V
Secondary Winding Type	WYE-GROUNDED
Percent Impedance	5.75
Primary Switch	REUSE EXISTING AIR INTERRUPTER SWITCH 600 A
Primary Connection	TRANSITION FROM EXISTING SWITCH
Secondary Connections	PROVIDE AND INSTALL NEW CONNECTIONS TO EXISTING SWITCHGEAR EXTEND IF REQUIRED
Secondary Breaker	REUSE EXISTING 800 A SECONDARY BREAKER AND SWITCHGEAR
Maximum No-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP
Maximum Full-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP

* Replacing existing 500 KVA PCB transformer.

No diagram provided.

TRANSFORMER DATA SHEET

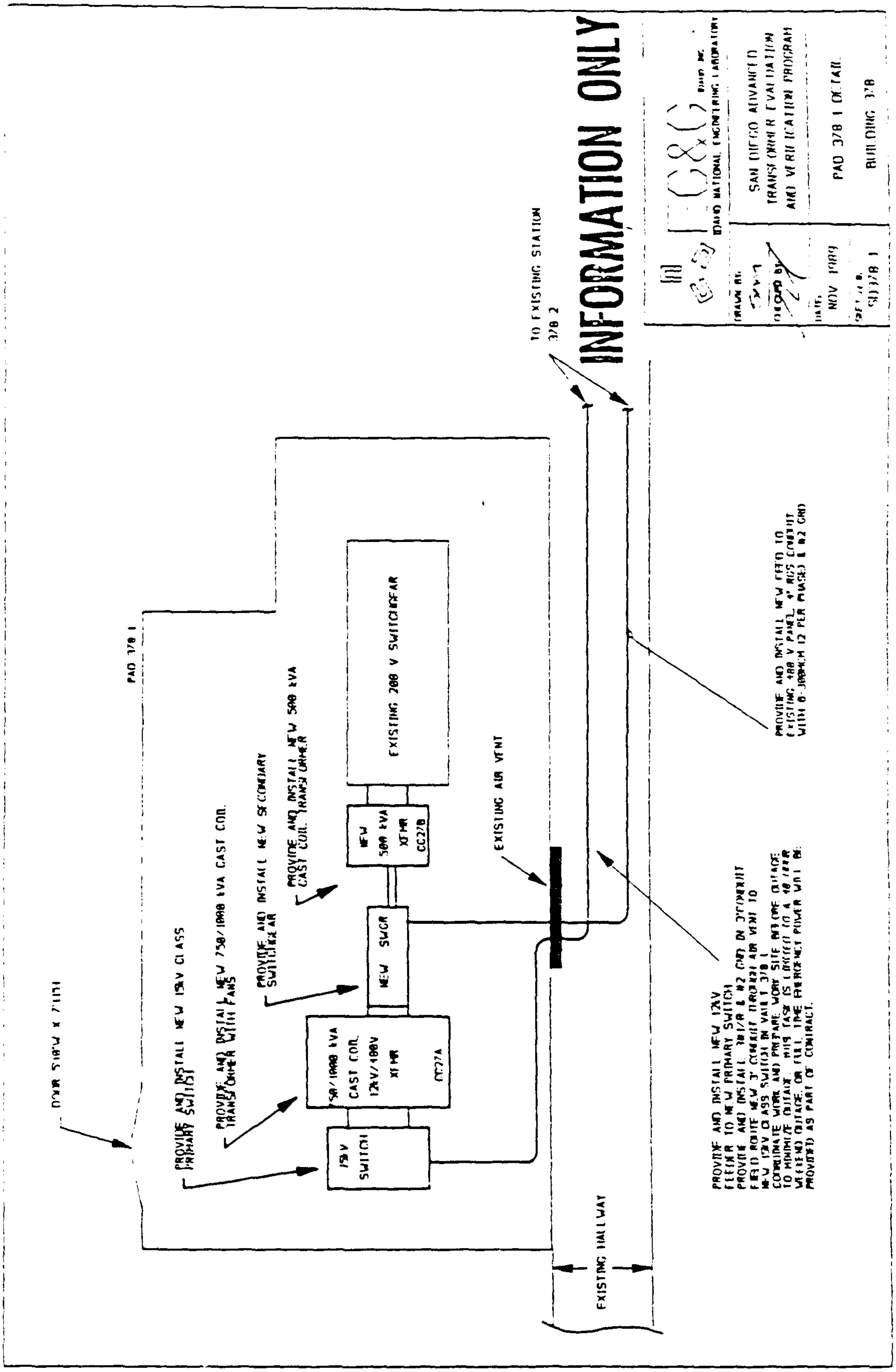
Transformer Identification	(PWC27-OLD) CC27A-NEW *
Location	BLDG 378-1
Size	750/1000 KVA **
Primary Voltage	12 KV
Primary Winding Type	DELTA
Secondary Voltage	480 V
Secondary Winding Type	WYE-GROUNDED
Percent Impedance	5.75
Primary Switch	PROVIDE AND INSTALL NEW 15 KV CLASS PRIMARY SWITCH AND NEW 12 KV FEEDER
Primary Connection	TRANSITION TO NEW SWITCH
Secondary Connections	NEW COPPER BUS CONNECTIONS TO NEW SWITCHGEAR
Secondary Breaker	P & I NEW SWITCHGEAR, SEE SKETCH BREAKER AND SWITCHGEAR
Maximum No-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP
Maximum Full-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP

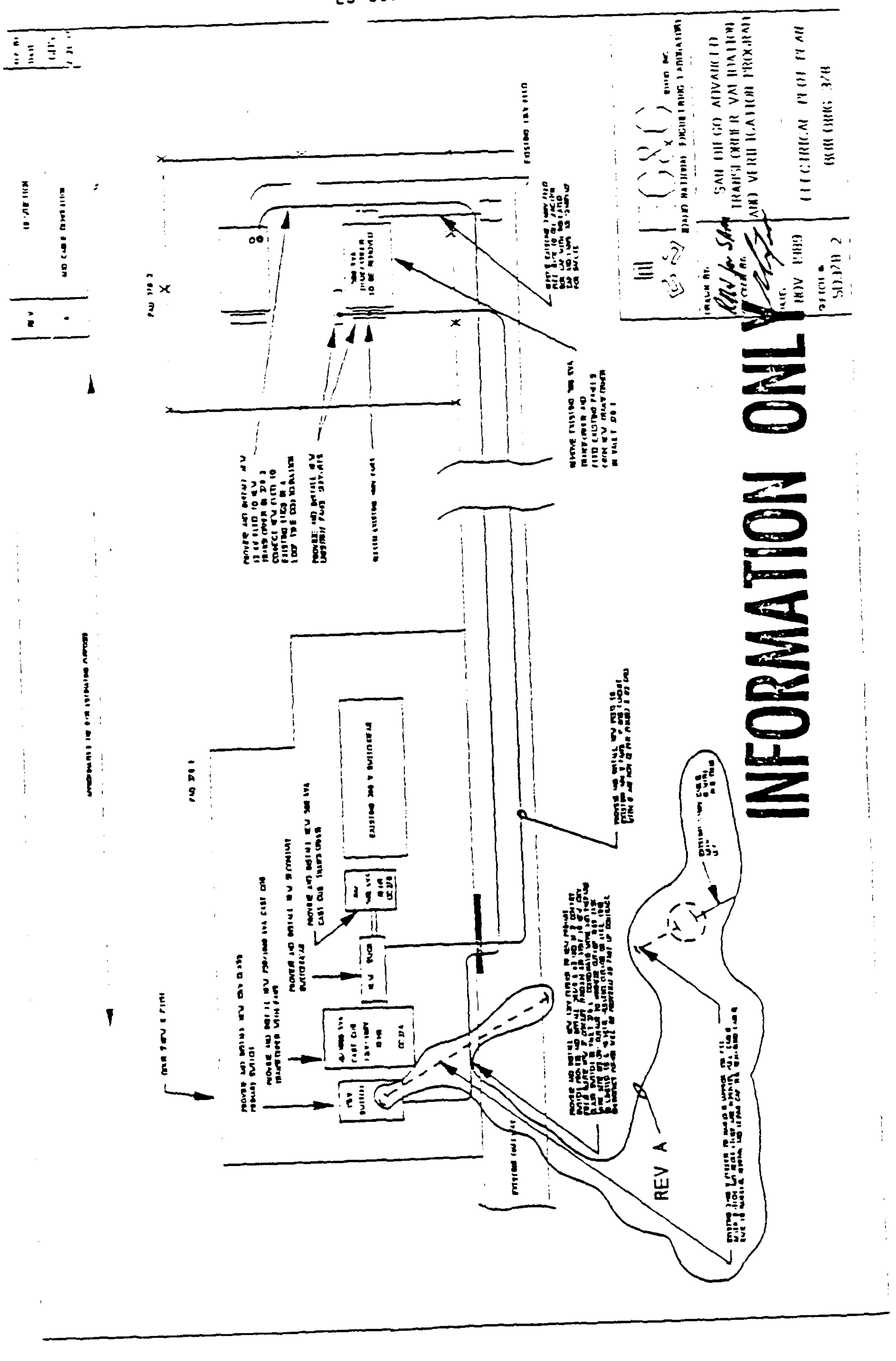
* This unit is replacing an existing 1000 KVA PCB filled transformer.
** Supply fans to achieve higher rating.

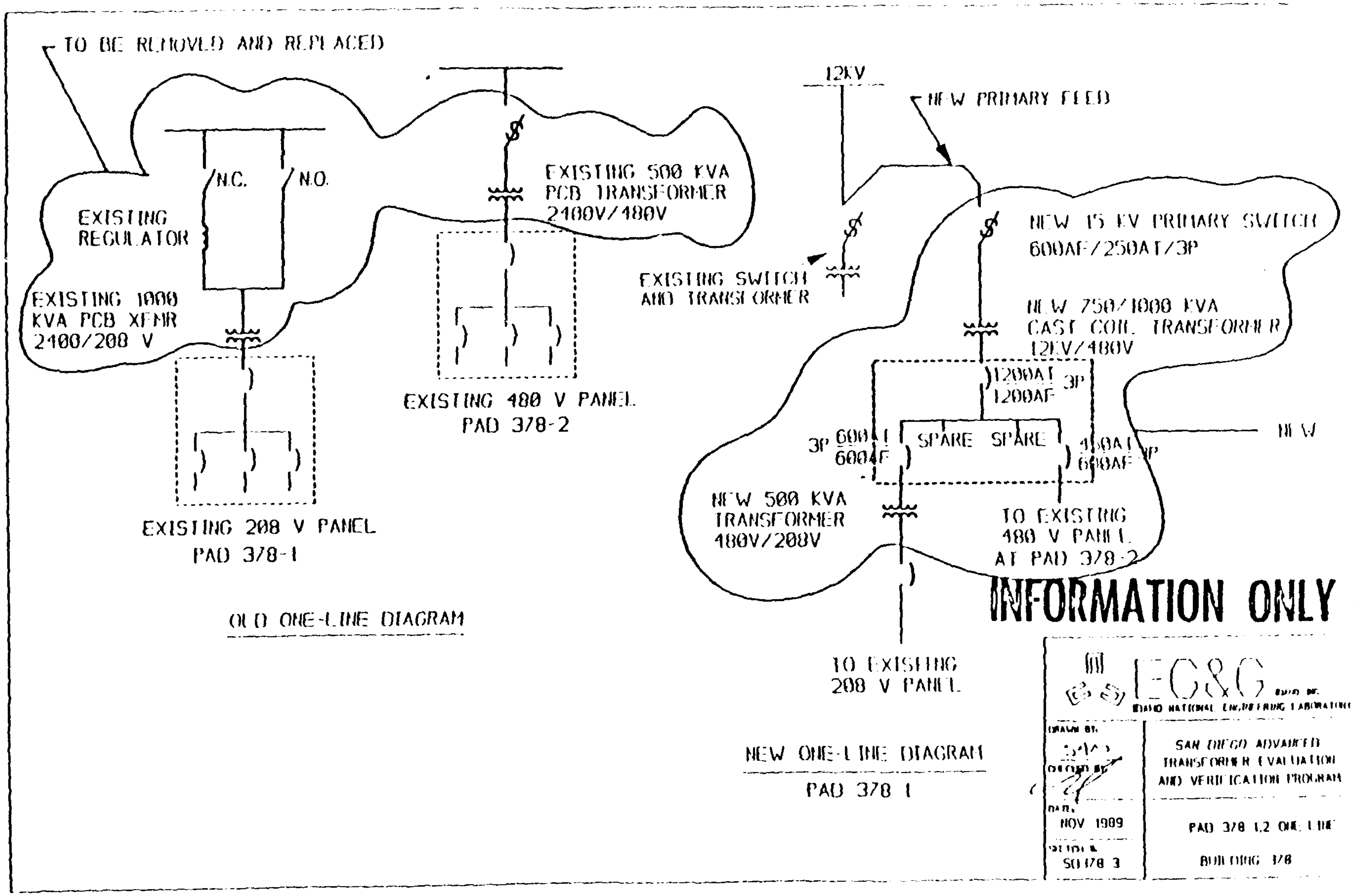
TRANSFORMER DATA SHEET

Transformer Identification	(PWC27-OLD) CC27B-NEW
Location	BLDG 378-1
Size	500 KVA *
Primary Voltage	480 V
Primary Winding Type	DELTA
Secondary Voltage	208 V
Secondary Winding Type	WYE-GROUNDED
Percent Impedance	5.75
Primary Switch	PROVIDE AND INSTALL NEW SWITCHGEAR SEE SKETCH
Primary Connection	TRANSITION FROM NEW SWITCHGEAR
Secondary Connections	NEW COPPER BUS CONNECTIONS TO EXISTING SWITCHGEAR
Secondary Breaker	REUSE EXISTING SWITCHGEAR
Maximum No-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP
Maximum Full-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP

* No primary voltage taps are required on this transformer due to the high current level. Note requested optional price for addition of standard primary voltage taps on this unit in the pricing schedule.


INFORMATION ONLY
EG&G IDAHO INC.
IDAHO NATIONAL ENGINEERING LABORATORY
SAN DIEGO ADVANCED TRANSFORMER EVALUATION AND VERIFICATION PROGRAM
PAD 378 1 DETAIL
BUILDING 378
NOV 1989
TO EXISTING STATION 378 2
PAD 378 1
PROVIDE AND INSTALL NEW 15kV CLASS PRIMARY SWITCH
PROVIDE AND INSTALL NEW 750/1000 kVA CAST COIL TRANSFORMER WITH FANS
PROVIDE AND INSTALL NEW SECONDARY SWITCHGEAR
PROVIDE AND INSTALL NEW 500 kVA CAST COIL TRANSFORMER
EXISTING 208 V SWITCHGEAR
NEW 500 kVA XFMR CC27B
NEW SWGR
750/1000 kVA CAST COIL 12kV/480V XFMR CC27A
15kV SWITCH
EXISTING AIR VENT
EXISTING HALLWAY
PROVIDE AND INSTALL NEW 12kV FEEDER TO NEW PRIMARY SWITCH
PROVIDE AND INSTALL NEW FEED TO EXISTING 480 V PANEL


INFORMATION ONLY
REV A



TO BE REMOVED AND REPLACED
EXISTING REGULATOR
N.C.
N.O.
EXISTING 1000 KVA PCB XFMR 2400/208 V
EXISTING 208 V PANEL
PAD 378-1
EXISTING 500 KVA PCB TRANSFORMER 2400V/480V
EXISTING 480 V PANEL
PAD 378-2
OLD ONE-LINE DIAGRAM
12KV
NEW PRIMARY FEED
EXISTING SWITCH AND TRANSFORMER
NEW 15 KV PRIMARY SWITCH
600AF/250AT/3P
NEW 750/1000 KVA CAST COIL TRANSFORMER
12KV/480V
1200AT 3P
1200AF
3P 600AT
600AF
SPARE
SPARE
NEW
NEW 500 KVA TRANSFORMER 480V/208V
TO EXISTING 480 V PANEL AT PAD 378-2
TO EXISTING 208 V PANEL
NEW ONE-LINE DIAGRAM
PAD 378 1
INFORMATION ONLY
EG&G
IDAHO NATIONAL ENGINEERING LABORATORY
DRAWN BY
CHECKED BY
DATE
NOV 1989
SAN DIEGO ADVANCED TRANSFORMER EVALUATION AND VERIFICATION PROGRAM
PAD 378 1,2 ONE LINE
BUILDING 378

TRANSFORMER DATA SHEET

Transformer Identification	(PWC49-OLD) CC49-NEW *
Location	BLDG 489-1
Size	1500 KVA
Primary Voltage	12 KV
Primary Winding Type	DELTA
Secondary Voltage	480/277 V
Secondary Winding Type	WYE-GROUNDED
Percent Impedance	5.75
Primary Switch	REINSTALL EXISTING PRIMARY SWITCH
Primary Connection	CONNECT EXISTING SWITCH
Secondary Connections	NEW COPPER BUS CONNECTIONS TO EXISTING SWITCHGEAR
Secondary Breaker	EXISTING SWITCHGEAR
Maximum No-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP
Maximum Full-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP

* The existing PCB unit is already missing and will not have to be handled as part of this changeout.

Note: This unit will be installed in an existing station. The installer will have to remove an existing temporary transformer and place it aside for removal by others prior to installing the new transformer. The installer will also have to reinstall the existing primary switch, which was disconnected while the temporary transformer was installed. The existing temporary transformer is a 3750 KVA unit and will require an oversized crane to lift out and set on the ground. This unit is nonPCB and will not require additional handling.

No diagram provided.

ES-51334

TRANSFORMER DATA SHEET

Transformer Identification	(PWC1-220,1,2-OLD) CC1-220-NEW *
Location	BLDG 379-3
Size	300 KVA
Primary Voltage	2.4/12 KV DUAL **
Primary Winding Type	DELTA
Secondary Voltage	240 V
Secondary Winding Type	WYE-GROUNDED
Percent Impedance	4.5
Primary Switch	REUSE EXISTING PRIMARY SWITCH ***
Primary Connection	PROVIDE NEW CABLE CONNECTIONS TO EXISTING SWITCH
Secondary Connections	PROVIDE NEW CONDUIT AND CONDUCTORS TO EXISTING SWITCHGEAR
Secondary Breaker	REUSE EXISTING SWITCHGEAR
Maximum No-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP
Maximum Full-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP

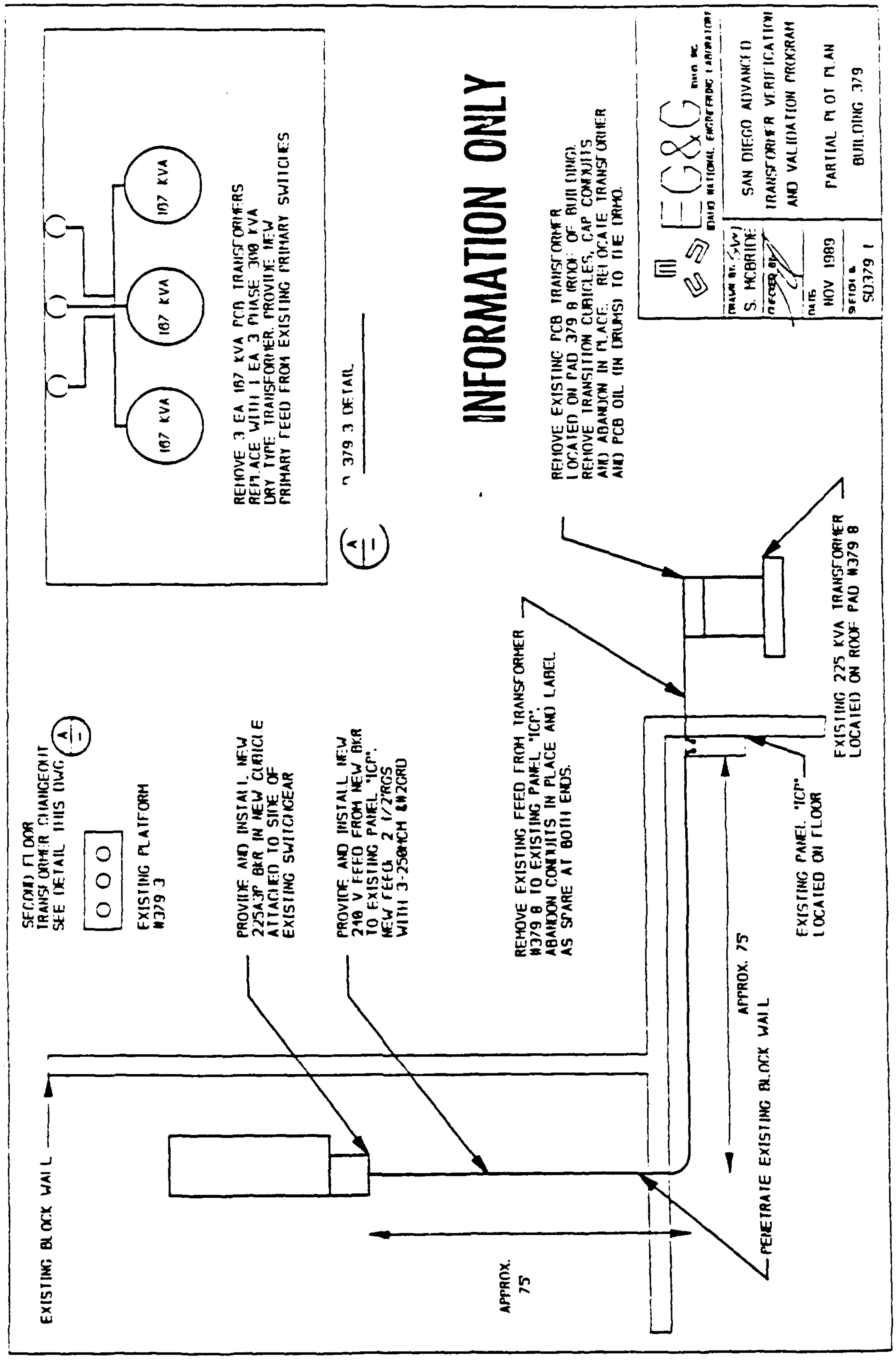
A

* This new three phase transformer is replacing three existing 167 KVA single phase PCB transformers.

** Dual voltage primary winding is an option. Regardless of whether the option is exercised, the 2400 VAC primary must be supplied. If the option is exercised then taps shall be provided for the higher rating (12 KV).

*** There are three oil-fused contactors which are feeding the transformer to be removed. It is believed that the three contactors are PCB-contaminated, and they should not be disturbed.

A



SECOND FLOOR TRANSFORMER CHANGEOUT SEE DETAIL THIS DWG
A
EXISTING PLATFORM #379 3
PROVIDE AND INSTALL NEW 225A3P BKR IN NEW CUBICLE ATTACHED TO SIDE OF EXISTING SWITCHGEAR
PROVIDE AND INSTALL NEW 240 V FEED FROM NEW BKR TO EXISTING PANEL "ICP". NEW FEED 2 1/2"RGS WITH 3-250MCM &#2GRD
REMOVE EXISTING FEED FROM TRANSFORMER #379 8 TO EXISTING PANEL "ICP". ABANDON CONDUITS IN PLACE AND LABEL AS SPARE AT BOTH ENDS.
EXISTING 225 KVA TRANSFORMER LOCATED ON ROOF PAD #379 8
EXISTING PANEL "ICP" LOCATED ON FLOOR
APPROX. 75'
PENETRATE EXISTING BLOCK WALL
EXISTING BLOCK WALL
APPROX. 75'
167 KVA
167 KVA
167 KVA
REMOVE 3 EA 167 KVA PCB TRANSFORMERS REPLACE WITH 1 EA 3 PHASE 300 KVA DRY TYPE TRANSFORMER. PROVIDE NEW PRIMARY FEED FROM EXISTING PRIMARY SWITCHES
379 3 DETAIL
A
INFORMATION ONLY
REMOVE EXISTING PCB TRANSFORMER LOCATED ON PAD 379 8 (ROOF OF BUILDING). REMOVE TRANSITION CUBICLES, CAP CONDUITS AND ABANDON IN PLACE. RELOCATE TRANSFORMER AND PCB OIL (IN DRUMS) TO THE DRMO.
EG&G IDAHO INC.
IDAHO NATIONAL ENGINEERING LABORATORY
SAN DIEGO ADVANCED TRANSFORMER VERIFICATION AND VALIDATION PROGRAM
PARTIAL PLOT PLAN
BUILDING 379
DRAWN BY
S. MCBRIDE
CHECKED BY
DATE
NOV 1989
SKETCH #
SD379 1

ES-51334

TRANSFORMER DATA SHEET

Transformer Identification	(PWC1-158-OLD) CC1-158-NEW *
Location	BLDG 333-1 **
Size	112.5 KVA
Primary Voltage	480 V
Primary Winding Type	DELTA
Secondary Voltage	208/120 V
Secondary Winding Type	WYE-GROUNDED
Percent Impedance	4.5
Primary Switch	PROVIDE AND INSTALL NEW 480 V BREAKER IN NEW SWITCHGEAR. SEE SKETCHES
Primary Connection	SEE SKETCHES
Secondary Connections	TRANSITION TO EXISTING PANEL
Secondary Breaker	REUSE EXISTING
Maximum No-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP
Maximum Full-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP

* This unit replaces the existing 112.5 KVA PCB transformer.

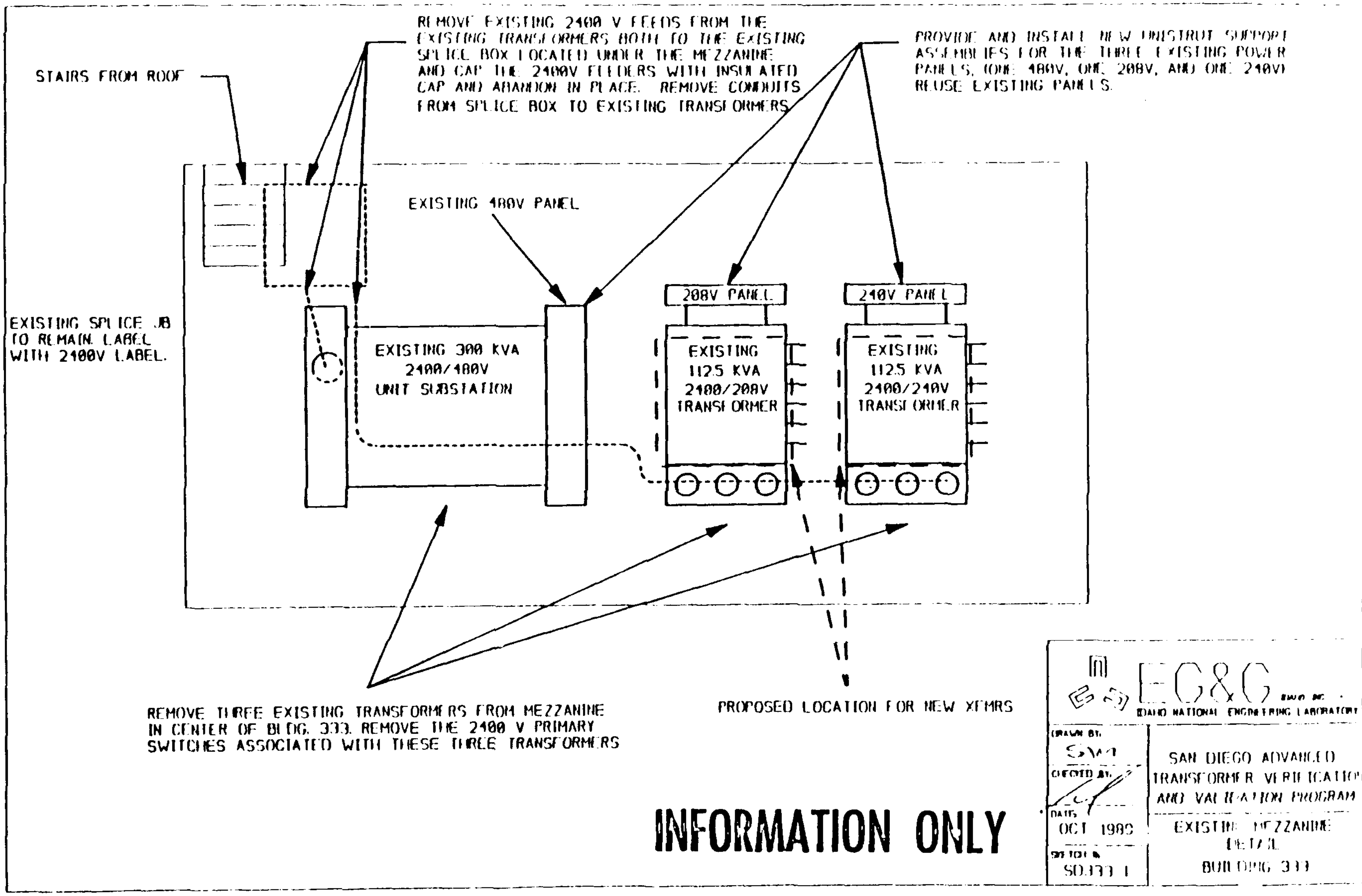
** This transformer will be installed on a mezzanine located approximately 30 feet AAF. Extra rigging and PCB handling efforts will be required.

TRANSFORMER DATA SHEET

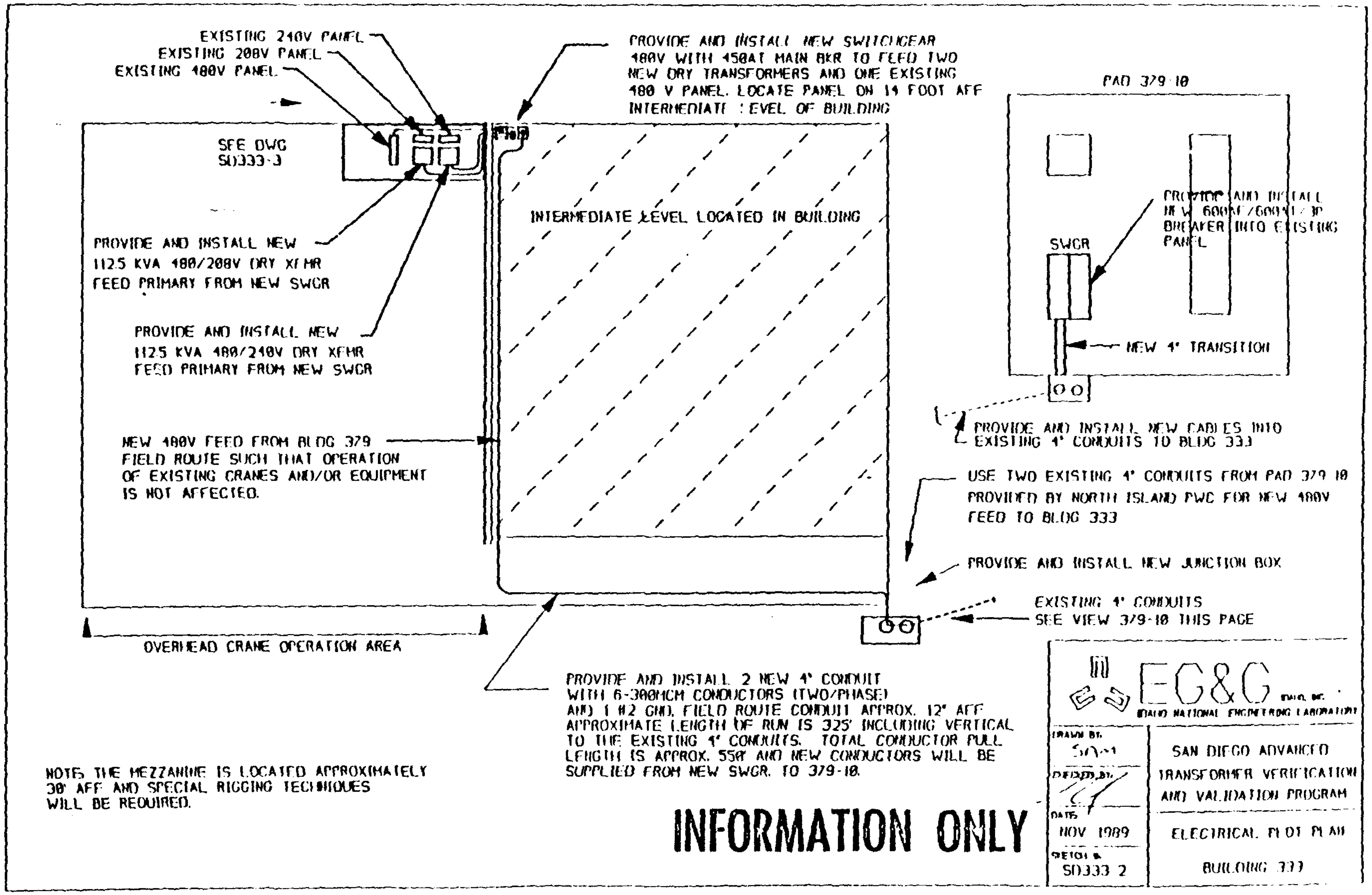
Transformer Identification	(PWC1-157-OLD) CC1-157-NEW *
Location	BLDG 333-1 **
Size	112.5 KVA
Primary Voltage	480 V
Primary Winding Type	DELTA
Secondary Voltage	240 V
Secondary Winding Type	WYE
Percent Impedance	4.5
Primary Switch	PROVIDE AND INSTALL NEW 480 V BREAKER IN NEW SWITCHGEAR. SEE SKETCHES.
Primary Connection	SEE SKETCHES
Secondary Connections	TRANSITION TO EXISTING PANEL
Secondary Breaker	REUSE EXISTING BREAKER
Maximum No-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP
Maximum Full-Load Loss	DETERMINED PER LOSS EVALUATION IN RFP

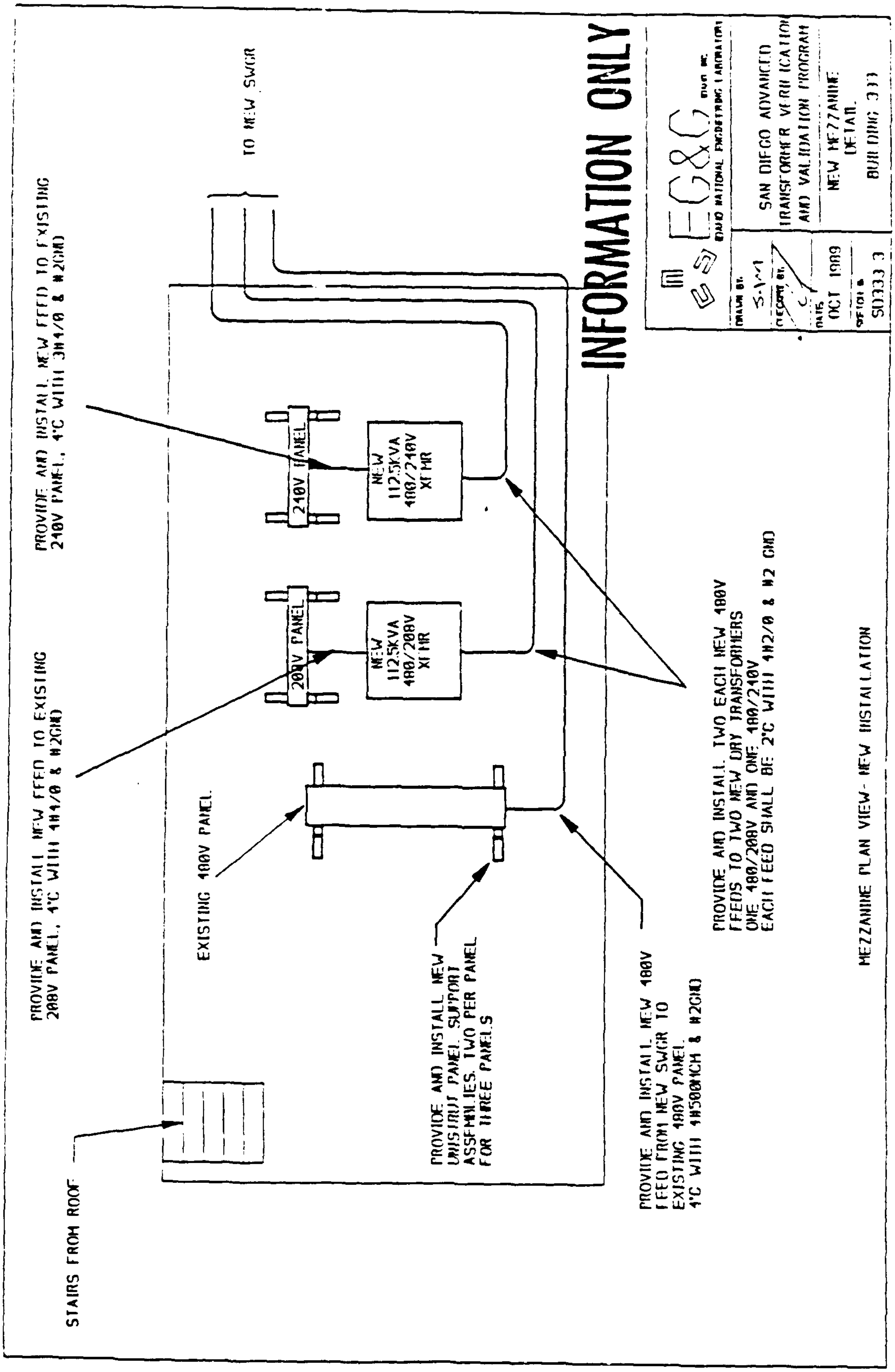
* This unit is replacing the existing 112.5 KVA PCB transformer.

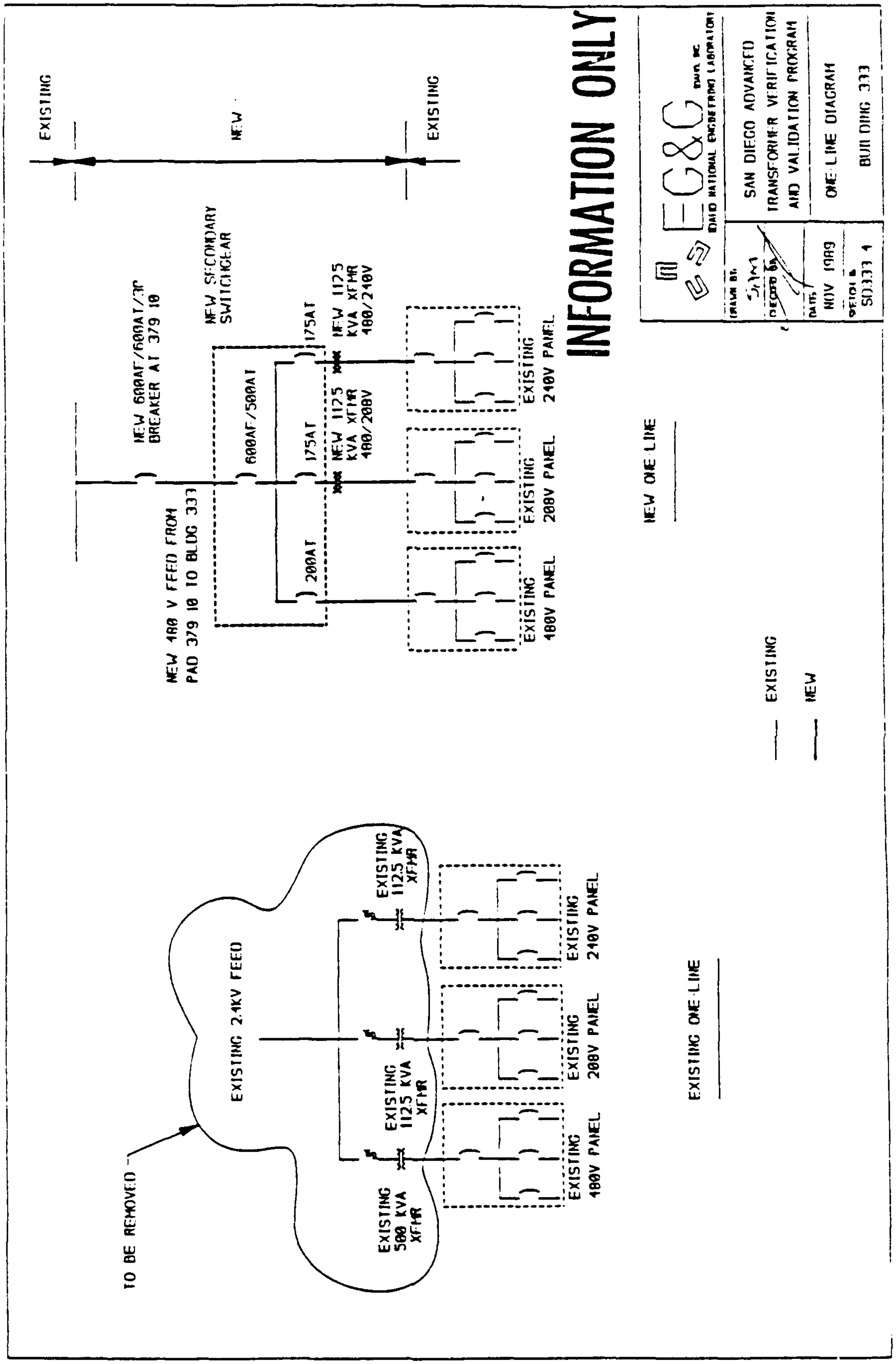
** This transformer will be installed on a mezzanine located approximately 30 feet AFF. Extra rigging and PCB handling efforts will be required.



STAIRS FROM ROOF
REMOVE EXISTING 2400 V FEEDS FROM THE EXISTING TRANSFORMERS BOTH TO THE EXISTING SPLICE BOX LOCATED UNDER THE MEZZANINE AND CAP THE 2400V FEEDERS WITH INSULATED CAP AND ABANDON IN PLACE. REMOVE CONDUITS FROM SPLICE BOX TO EXISTING TRANSFORMERS
PROVIDE AND INSTALL NEW UNISTRUT SUPPORT ASSEMBLIES FOR THE THREE EXISTING POWER PANELS, (ONE 480V, ONE 208V, AND ONE 240V) REUSE EXISTING PANELS.
EXISTING 480V PANEL
EXISTING SPLICE JB TO REMAIN. LABEL WITH 2400V LABEL.
EXISTING 300 KVA 2400/480V UNIT SUBSTATION
208V PANEL
EXISTING 112.5 KVA 2400/208V TRANSFORMER
240V PANEL
EXISTING 112.5 KVA 2400/240V TRANSFORMER
REMOVE THREE EXISTING TRANSFORMERS FROM MEZZANINE IN CENTER OF BLDG. 333. REMOVE THE 2400 V PRIMARY SWITCHES ASSOCIATED WITH THESE THREE TRANSFORMERS
PROPOSED LOCATION FOR NEW XFMRS
INFORMATION ONLY
EG&G IDAHO INC.
IDAHO NATIONAL ENGINEERING LABORATORY
DRAWN BY:
CHECKED BY:
DATE: OCT 1989
SAN DIEGO ADVANCED TRANSFORMER VERIFICATION AND VALIDATION PROGRAM
EXISTING MEZZANINE DETAIL
BUILDING 333
SD333-1


EXISTING 240V PANEL
EXISTING 208V PANEL
EXISTING 480V PANEL
SEE DWG SD333-3
PROVIDE AND INSTALL NEW 1125 KVA 480/208V DRY XFMR FEED PRIMARY FROM NEW SWGR
PROVIDE AND INSTALL NEW 1125 KVA 480/240V DRY XFMR FEED PRIMARY FROM NEW SWGR
NEW 480V FEED FROM BLDG 379 FIELD ROUTE SUCH THAT OPERATION OF EXISTING CRANES AND/OR EQUIPMENT IS NOT AFFECTED.
OVERHEAD CRANE OPERATION AREA
PROVIDE AND INSTALL NEW SWITCHGEAR 480V WITH 450AT MAIN BKR TO FEED TWO NEW DRY TRANSFORMERS AND ONE EXISTING 480 V PANEL. LOCATE PANEL ON 14 FOOT AFF INTERMEDIATE LEVEL OF BUILDING
INTERMEDIATE LEVEL LOCATED IN BUILDING
PAD 379-10
SWGR
NEW 4" TRANSITION
PROVIDE AND INSTALL NEW CABLES INTO EXISTING 4" CONDUITS TO BLDG 333
USE TWO EXISTING 4" CONDUITS FROM PAD 379-10 PROVIDED BY NORTH ISLAND PWC FOR NEW 480V FEED TO BLDG 333
PROVIDE AND INSTALL NEW JUNCTION BOX
EXISTING 4" CONDUITS
SEE VIEW 379-10 THIS PAGE
PROVIDE AND INSTALL 2 NEW 4" CONDUIT WITH 6-300MCM CONDUCTORS (TWO/PHASE) AND 1 #2 GND. FIELD ROUTE CONDUIT APPROX. 12' AFF. APPROXIMATE LENGTH OF RUN IS 325' INCLUDING VERTICAL TO THE EXISTING 4" CONDUITS. TOTAL CONDUCTOR PULL LENGTH IS APPROX. 550' AND NEW CONDUCTORS WILL BE SUPPLIED FROM NEW SWGR. TO 379-10.
NOTE: THE MEZZANINE IS LOCATED APPROXIMATELY 30' AFF AND SPECIAL RIGGING TECHNIQUES WILL BE REQUIRED.
INFORMATION ONLY
EG&G IDAHO, INC.
IDAHO NATIONAL ENGINEERING LABORATORY
DRAWN BY
CHECKED BY
DATE
NOV 1989
SKETCH
SD333 2
SAN DIEGO ADVANCED TRANSFORMER VERIFICATION AND VALIDATION PROGRAM
ELECTRICAL PLOT PLAN
BUILDING 333


TO NEW SWGR
PROVIDE AND INSTALL NEW FEED TO EXISTING 240V PANEL, 4'C WITH 3#4/0 & #2GND
240V PANEL
NEW 112.5KVA 480/240V XFMR
208V PANEL
NEW 112.5KVA 480/208V XFMR
PROVIDE AND INSTALL NEW FEED TO EXISTING 208V PANEL, 4'C WITH 4#4/0 & #2GND
EXISTING 480V PANEL
PROVIDE AND INSTALL NEW UNISTRUT PANEL SUPPORT ASSEMBLIES. TWO PER PANEL FOR THREE PANELS
PROVIDE AND INSTALL NEW 480V FEED FROM NEW SWGR TO EXISTING 480V PANEL 4'C WITH 4#500MCM & #2GND
PROVIDE AND INSTALL TWO EACH NEW 480V FEEDS TO TWO NEW DRY TRANSFORMERS ONE 480/208V AND ONE 480/240V EACH FEED SHALL BE 2'C WITH 4#2/0 & #2 GND
STAIRS FROM ROOF
MEZZANINE PLAN VIEW- NEW INSTALLATION
INFORMATION ONLY
EG&G
IDAHO NATIONAL ENGINEERING LABORATORY
SAN DIEGO ADVANCED TRANSFORMER VERIFICATION AND VALIDATION PROGRAM
NEW MEZZANINE DETAIL
BUILDING 333
DRAWN BY
CHECKED BY
DATE
OCT 1989
SD333 3


EXISTING
NEW
EXISTING
NEW 600AF/600AT/3Φ BREAKER AT 379 10
NEW SECONDARY SWITCHGEAR
NEW 480 V FEED FROM PAD 379 10 TO BLDG 333
600AF/500AT
175AT
175AT
200AT
NEW 1125 KVA XFMR 480/240V
NEW 1125 KVA XFMR 480/208V
EXISTING 240V PANEL
EXISTING 208V PANEL
EXISTING 480V PANEL
NEW ONE-LINE
INFORMATION ONLY
EG&G IDAHO INC.
IDAHO NATIONAL ENGINEERING LABORATORY
SAN DIEGO ADVANCED TRANSFORMER VERIFICATION AND VALIDATION PROGRAM
ONE-LINE DIAGRAM
BUILDING 333
DRAWN BY
CHECKED BY
DATE
NOV 1989
SD333 4
EXISTING
NEW
EXISTING 2.4KV FEED
EXISTING 112.5 KVA XFMR
EXISTING 112.5 KVA XFMR
EXISTING 500 KVA XFMR
TO BE REMOVED
EXISTING 240V PANEL
EXISTING 208V PANEL
EXISTING 480V PANEL
EXISTING ONE-LINE

APPENDIX B

VENDOR DATA REQUIREMENT LIST

APPENDIX B

VENDOR DATA REQUIREMENTS LIST

Description	* When Required	Copies Required	No.of Reference Paragraph	** Approval Req'd.by	
1. Drawings, sketches, schematics and other data shall be submitted with the bid sufficient for evaluation of contract proposal.	BC	12	NA	R	AB/DE
2. Quality Manual and Procedures	BC	12	4.0	R	AB/DE
3. Inspection and Test Procedures	BFR	12	3.2, 3.10	I	AB/DE
4. Inspection and Test Results	PS	12	3.10	R	AB/DE
5. Maintenance manual which includes as a minimum: installation instructions, operating instructions, preventive and corrective maintenance tasks, the frequency of each task, the tools, equipment, and procedures with special emphasis on safety precautions for the accomplishments of each task.	PS	12	5.0	I	AB/DE
6. Priced spare parts list and recommended spares.	PS	12	5.0	I	AB/D
7. Guaranteed performance data and name plate data.	PS	12	5.0	I	AB/DE
8. As-built shop drawings schematics and wiring diagram.	PS	12	5.0	R	AB/DE
9. Installation schedule.	PS	12	5.0		AB/DE
10. PCB fluid disposal plan and certification.	PS	12	5.0		AB/DE
11. Spill Prevention, Control, and Countermeasures Plan	BFR	12	NA	R	AB/DE
12. Certification for Hazardous Waste Handlers	PS	12	NA	R	AB/DE

* BFR = Before Fabrication Release
* PS = Prior to Shipment
** I = Information Only
** DE = Approval By Design Engineer
* BC = Before contract is awarded
** R = Required
** AB = Approval By Buyer

APPENDIX C

CONSTRUCTION DETAILS

CONSTRUCTION DETAILS

ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

DESCRIPTION OF WORK:

Summary: The electrical work can be generally summarized in the following manner, but this is not by way of limitation:

- Obtain permits for moving hazardous waste.
- Check and mark phase rotation before de-energizing system.
- Have PWC personnel de-energize the existing transformers.
- Test existing transformer for no-load losses. Drain the PCB fluid from each transformer into standard DOT approved drums and deliver it to the interim hazardous waste storage area on the base as designated by the Resident Engineer (all work shall comply with OSHA and EPA regulations).
- Purge the transformer case with dry nitrogen and seal.
- Deliver the existing transformer to the interim hazardous waste storage area on the base (comply with OSHA and EPA regulations).
- Provide and install new transformers.
- Connect new transformers and test.
- Request PWC personnel to energize the system.
- Verify proper operations and turn the operating transformer over to EG&G Idaho, Inc. for remanding to PWC San Diego.

PART 2 - MISCELLANEOUS AND ANCILLARY PRODUCTS

GENERAL:

Furnish all labor, materials, equipment, and appliances required to complete the installation of the complete electrical systems. All labor, materials, service, equipment, and workmanship shall conform to the applicable chapters of the NEC (NFPA 70) and other authorities having lawful jurisdiction pertaining to the work required. All modifications required by these codes, rules, regulations, and authorities shall be made by the Subcontractor without additional charge to the Contractor.

Underwriter's Laboratories (UL): All materials, appliances, equipment, or devices shall conform to the applicable standards of UL where such standards exist. All material, appliances, equipment, or devices shall be listed and/or labeled by UL where such standards exist.

Completed electrical system shall conform with applicable provisions of the Special Conditions, the Technical Specification, and the attached subcontract drawings.

CONDITION OF PRODUCTS:

Except as otherwise indicated, provide new electrical products, free of defects and harmful deterioration at the time of installation. Provide each product complete with trim, accessories, finish guards, safety devices, and similar components specified or recognized as integral parts of the product, or required by governing regulations.

UNIFORMITY:

Where multiple units of a product are required for the electrical work, provide identical products by the same manufacturer without variations except for sizes and similar variations as indicated.

PART 3 - EXECUTION:

COORDINATION OF ELECTRICAL WORK:

General: It is recognized that the subcontract documents are diagrammatic in showing certain physical relationships that must be established within the electrical work and in its interface with other work, including utilities and mechanical work, and that such establishment is the exclusive responsibility of the Subcontractor.

Arrange electrical work in a neat, well-organized manner with conduit and similar services running parallel with the primary lines of the building construction and with a minimum of 7 feet overhead clearance where possible.

Locate operating and control equipment properly to provide easy access and arrange entire electrical work with adequate access for operation and maintenance.

RESIDENT ENGINEER:

The EG&G Idaho Resident Engineer will ensure that the installation complies with drawings, specifications, and witness testing.

TRANSFORMERS

PART 1 - GENERAL

WORK DESCRIPTION:

Provide and install transformers of sizes, ratings, and types as shown on the referenced data sheets and engineering specification.

PART 2 - PRODUCTS

MATERIALS:

The transformers shall be as shown on the attached data sheets and shall be installed at the location indicated on the drawings.

The transformer enclosure shall be suitable for the environment that the transformer is installed in.

PART 3 - EXECUTION

INSTALLATION:

Install transformers as indicated on the drawings and in accordance with manufacturer's written instructions, applicable requirements of NEC and the NEC Association's "Standard of Installation," and complying with recognized industry practices to ensure that products serve intended functions.

TESTING:

Visually inspect to determine that equipment installation conforms to NEC, these specifications, and the drawings and testing as described under the testing section of the specification.

GROUNDING

PART 1 - GENERAL

WORK DESCRIPTION:

Provide and install grounding on all transformer cases and tie into the existing grounding system.

PART 2 - PRODUCTS

MATERIALS:

Grounding electrode wire shall be a minimum of No. 2 AWG bare stranded copper and comply with NEC Table 250-94.

Ground grid welds shall be made by the Thermit process.

PART 3 - EXECUTION

INSTALLATION:

Install a complete grounding system for the transformers in accordance with applicable requirements of NEC and complying with recognized industry practices to ensure that products serve intended functions and comply with requirements. All exposed noncurrent-carrying metallic parts of electrical equipment, conduits, grounding conductor of nonmetallic sheathed cables, and neutral conductor of the wiring system shall be grounded.

Exothermic Welds: Exothermic welds shall be made in accordance with the manufacturer's written recommendations. No mechanical connector is required at exothermic weldments.

TESTING:

Visually inspect to determine that ground installation conforms to NEC, these specifications, and the drawings.

CABLE, WIRE, CONNECTORS AND MISCELLANEOUS DEVICES

PART 1 - GENERAL

WORK DESCRIPTION:

Provide and install conduit systems, cables, wires, and wiring connectors of sizes, ratings, materials, and types as shown on the drawings.

PART 2 - PRODUCTS

WIRING MATERIALS 5 KV AND 15 KV CLASS:

All 5 KV and 15 KV cable shall be shielded and properly terminated. Cable shall be EPR MV-90 shielded cable and shall have a 133% insulation level.

HIGH VOLTAGE SPLICES:

Splices in high voltage cables. Splices shall be suitable for continuous immersion in water and shall be made only in accessible locations in manholes.

Certification. High voltage cable splicer/terminator certification of competency and experience shall be submitted 30 days before splices or terminations are made in high voltage cables. Splicer/terminator experience during the past 3 years shall include performance in splicing and terminating all cables of the type and classification being provided under this contract.

Kit Methods. High voltage splices shall be made using a "kit," which shall be the product of one manufacturer and shall have the approval in writing of the manufacturer of the cable that is to be spliced. The Contractor shall provide for continuous submersion in water.

Heat-Shrink Method. All splices for 600 volt and less cables shall be done by the heat-shrink method. Provide heavy-wall heat-shrinkable splice tubing rated for sealed underground connector systems. Tubing shall be available uncoated, or with a thermoplastic adhesive-sealant that adheres to PVC, neoprene, polyolefin, and EPR aluminum or steel.

Splices in High Voltage Cables. Splices shall be suitable for continuous immersion in water and shall be made only in accessible locations in manholes.

Certification. High voltage cable splicer/terminator certification of competency and experience shall be submitted 30 days before splices or terminations are made in high voltage cables. Splicer/terminator experience during the past 3 years shall include performance in splicing and terminating cables of the type and classification being provided under this contract.

Kit Methods. High voltage splices shall be made using a "kit," which shall be the product of one manufacturer and shall have the approval in writing of the manufacturer of the cable that is to spliced. The contractor shall provide the Contracting Officer or Contractor's Quality Control representative with a copy of the manufacturer's instructions before splicing is started. Splices shall be made only in manholes.

Splices in Shielded Cables. Splices in shielded cables shall include covering the spliced area with metallic tape, or like material, to the original cable shield and connecting it to the cable on each side of the slice. Provide a No. 6 AWG bare copper ground connection brought out in a water tight manner and ground to a 3/4 inch x 10 feet ground rod as part of the splice installation. Wire shall be trained to the sides of the enclosure in a manner to avoid interference with the working area.

Phasing and Rotation. Contractor to record the phasing and rotation of the existing electrical system before cable splicing, cable removal, termination, and/or any work that could alter the phasing and rotation of the system. After completion of the work and before connecting any load to the system, the contractor shall verify that the phasing and rotation is as it existed and has not been altered.

WIRING MATERIALS, 600 V CLASS:

Conductors shall be stranded for all sizes of wire and cable.

Conductors shall be copper for all sizes.

Wire insulation shall be type THHN/THWN for all 600 volt conductors unless otherwise noted.

Minimum size of power conductors shall be No. 12.

Splices for 600 Volt Cables. Splices in underground systems shall be made only in accessible locations, such as manholes and handholes, using a compression connector of the conductor and by insulating and water proofing by a method suitable for continuous submersion in water.

Heat-Shrink Method. All splices for 600 volt and less cable shall be done by the heat-shrink method. Provide heavy-wall heat-shrinkable splice tubing rated for sealed underground connector systems. Tubing shall be available uncoated, or with a thermoplastic adhesive-sealant that adheres to PVC, neoprene, polyolefin, and EPR aluminum or steel.

CONNECTORS:

Compression and/or lug type connectors, such as "Burndy", shall be used for splicing No. 6, and larger 600 volt cable.

High Voltage Cable Terminations. IEEE 48, Class 2. Except as otherwise indicated, terminators for extruded insulation nonmetallic jacketed cables shall be porcelain insulator type. Apply terminator to single conductor cables or to each conductor of multiple conductor cable that are to the weather. Terminator shall not exude any filler compound under either test or service. The terminator shall consist of a porcelain insulator, cable connector-hoodnut assemble, and aerial lug, as required, metal body and supporting bracket, sealed cable entrance, and internal stress relief device for shielded cable, and insulating filler compound or material.

Terminator, Modular, Molded Rubber Type. IEEE 48, Class 2. Provide terminator as specified herein for terminating single conductor, or the single conductor of multiconductors, solid insulated, nonmetallic jacketed type cables for service voltage up to 35 KV outdoor. The terminator shall consist of a stress control, ground clamp, nontracking rubber skirts, crimp-on connector, rubber cap, and aerial lug. Provide heat-shrinkable elbow sealing adaptor as shown on plans, allowing the metallic cable shielding to be externally grounded and sealed. Separate parts of copper or copper alloy shall not be used in contact with aluminum or aluminum alloy parts in the construction and installation of the terminator.

Wire/Device Identification: All cable systems, major conduits, and devices shall be permanently marked. Conduits shall have stainless steel tags at every 60 feet or where wall or building penetrations occur. All conductors shall be identified with self-adhering oil and moisture resistant vinyl labels, covered with clear heat shrink tubing or white heat shrink tubing with black typed on letters with nonsmearing ink as manufactured by Brady, T&B, or approved equal. Hand lettered labels shall not be used. All conductors shall be clearly marked with the proper phase identification.

CONDUIT SYSTEM:

All conduits shall be RGS or IMC with exception of underground, which can be PVC, and which shall be 3 feet minimum below grade and encased in 2 inches minimum red concrete. All bends must be RGS or IMC. Conduit systems shall be completed per the NEC.

PART 3 - EXECUTION

INSTALLATION:

General: Install electrical cable, wire, and connectors as indicated on the drawings, in accordance with the manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure products serve intended functions.

Pull conductors together where more than one is being installed in a raceway. Do not exceed the conductor manufacturer's recommended pulling tension or as specified in the IPCS Handbook. Use pulling compound or lubricant, where necessary; compound must not deteriorate conductor or installation. Tension shall be monitored when pulls involve more than 40 feet or when 3 or more 90 degree turns are in the system.

Use pulling means including fish tape, cable, or rope which cannot damage raceway.

Install splices and taps in an accessible junction box that has mechanical strength and insulation rating equivalent-or-better than conductor.

Use splice and tape connectors that are compatible with conductor material.

TESTING:

High Potential: After installation and installing stress cones, all 15 KV cable shall be tested at twice the normal operating voltage plus 1000 volts. The test duration shall be 15 minutes on each cable. See IEEE standard 400-1980 (IEEE guide for making high-direct-voltage tests on power cable systems in the field).

Meggering: Before terminating, test all cable or wire for insulation resistance with 500 volt megger. Any wire with less than 10 megohms to ground or other conductors shall be replaced before proceeding with the terminating. List conductors tested on required test data submittal sheet.

ELECTRICAL CONTINUITY AND PHASE ROTATION:

After conductor connectors are installed and conductors are labeled, but before termination to terminals or devices, an electrical continuity test shall be performed on each conductor using a battery powered buzzer or ohmmeter to determine that all power, control, grounding, and other conductors are properly installed and identified. List all conductors tested on required test data submittal sheets.

After initial energizing of the transformer, check for proper phase rotation.

APPENDIX D

OUTLINE SPILL PREVENTION, CONTROL, AND COUNTERMEASURES PLAN

OUTLINE SPILL PREVENTION, CONTROL, AND COUNTERMEASURES PLAN

MINIMUM SPILL PREVENTION REQUIREMENTS

The following shall be performed before the start of and during any fluid removal from a liquid cooled transformer (i.e., PCB filled, oil filled, or silicone filled).

a. A layer of 6 mil polyethylene sheeting shall be placed around the transformer.

b. If drains are present, measures will be taken to eliminate the potential for any fluids from entering the drains. This includes, but is not limited to, constructing a dike, trenching around the drain, and/or plugging the drain.

c. Before pumping the fluids, all hoses shall be inspected for any holes, cracks, or deterioration. Fittings shall be inspected to ensure a proper connection. Any gaskets utilized in the pumping operations shall be inspected for integrity. Approved hoses, pumps, and gaskets shall be used.

d. Drip pans shall be placed under pumps and connections.

e. Pumps and hoses shall be positioned so as to minimize any tripping hazard.

f. Personnel will monitor the pumping operation at all times.

g. An adequate supply of absorbent materials and cleanup equipment shall be readily available in the event of a mishap.

This includes the following, but not limited to:

1. Shovels
2. Brooms
3. DOT drums: 17E, 17H, and 85 gallon recovery drum
4. Ample supply of rags
5. Vermiculite (Speedi-Dry)
6. Absorbent booms and/or absorbent pads
7. Assorted corks, plugs, and emergency seals
8. Material Safety Data Sheets (MSDS).

h. All safety equipment shall be inspected before use.

CONTROL

In the event of a spill or leak, the following procedure shall be implemented:

a. Stop the source of the spill. Below is a list of probable source of spills when working with liquid cooled transformers, and the remedial action to be taken to eliminate the problem.

Source 1. Transformer

1. Location of leaks: valves. Remedial action: plug valve to reduce or stop spill. Pump fluid below valve and replace faulty valve.

2. Location of leak: bushing. Remedial action: Pump fluid below bushing level. Replace gaskets, or if necessary, replace bushing.

3. Location of leak: tank wall or radiator pipe. Remedial action: pump fluid below level of leak and either epoxy or weld close the leak source. If the source of the leak is small, a vacuum can be pulled on the transformer before applying the epoxy sealant or welding. Pulling a vacuum on the transformer eliminates the need for any pumping operations.

4. Location of leak: tap changer, liquid level gauge, or temperature gauge. Remedial action: remove fluid below level and replace packing material, gaskets, or thread sealant where applicable.

Source 2. Pumps or Hoses

Remedial action: Stop all pumping operations and place apparatus into an adequate container to capture any fluids.

Source 3. Drums

Remedial action: In the event that the drum is seeping at the seams, the fluid shall immediately be transferred to another drum. Should a drum rupture or become punctured, an oversized recovery drum will be used. The recovery drum is placed over the top of the leaking drum. Then, the recovery drum is placed upright, containing the leaking drum.

b. Stop the migration of any spilled fluid. This can be done by placing the berm around perimeter of the spill. A berm can be constructed using any type of absorbent material, i.e., vermiculite (Speedi-Dry), sand, rags, absorbent boom or pads.

c. Solidify any free standing fluid.

d. Safety apparel shall be worn when dealing with spills involving PCB fluids.

COUNTERMEASURES

The countermeasure operations are the cleanup and disposal of all contaminated material that is a result of the spill. The primary goal of all cleanup activity is to maintain a safe environment.

a. Cleanup

1. Fluids: If the volume of fluids is great enough to where solidification is impractical, the liquid shall be pumped into DOT 17E drums. These drums must be properly labeled and dated.

2. Solids: Any porous solids (soils, asphalt, wood, paper, etc.) contaminated by the spill shall be placed into DOT 17H (removal head) drums. These drums must be properly labeled and dated.

3. Major Spills: In the event that the spill exceeds the control and cleanup capabilities that are onsite, an outside contractor, who specializes in environmental cleanup and has all permits and licenses required, must be contacted. This contractor must be equipped to handle various types of spills.

Analysis. During the cleanup operations, sampling, and analysis must be performed. The analytical data are needed to present an accurate picture of the following:

1. The extent of the spill

2. The effectiveness of the cleanup operations

3. The point in time when the environment has been decontaminated.

b. Disposal. The disposal of all contaminated materials must be in accordance with the applicable EPA regulations (40 CFR 761).

All work will be inspected by the EG&G Idaho, Inc. representative.

Transportation of hazardous waste to the disposal site shall conform to 40 CFR, Part 263. All Federal, state, and local permits and labeling and approvals shall be completed before the shipment of waste from the transformer site.

APPENDIX E

SWITCHGEAR SPECIFICATION

SWITCHGEAR SPECIFICATION

1.0 GENERAL

Provide and install switchgear with the transformer as referenced in the data sheets. The switchgear shall consist of one or more enclosed vertical sections joined together to form a rigid, free standing assembly. The construction of the switchgear shall meet the requirements of the NEC.

2.0 PRODUCTS

600 Volt: Switchgear shall be suitable for operation for 480 volt, 3 phase, 3 wire, 60 Hertz grounded service.

Vertical Sections: Vertical sections shall support the horizontal and vertical buses, covers, and doors, and shall be designed to allow for easy rearrangement of units. Vertical sections shall have structural supporting members formed of a minimum of 13 gauge hot-rolled steel. All finished surfaces shall be blemish-free. Each section shall be 90 inches high and shall have 7 gauge steel, 3 inches high, removable lifting angle and two 1-1/2 inches high base channels. Complete control center lineups shall be divided into shipping splits no wider than approximately 60 inches. A lifting angle shall be provided on the top of each shipping split and shall extend the entire width of the shipping split. Lifting angles shall be designed to support the entire weight of the switchgear and shall have access points or lifting eyes to facilitate handling. Base channels shall be provided with holes to permit bolting the switchgear to the floor. The entire assembly shall be constructed and packaged to withstand all stresses induced in transit and during installation. Switchgear shall be designed so that matching vertical sections of the same current rating and manufacture can be added later at either end of the lineup without use of transition sections and without difficulty. Removable end closing plates shall be provided to close off openings on the end of the lineup. A removable top plate shall be provided on each vertical section and shall be of one piece construction for added convenience in cutting conduit holes. The design shall allow use of the standard conduit entrance area without significant sag or deformation of the top plate.

Vertical sections shall be designed to accommodate plug-on units in front-of-board construction. Vertical sections housing plug-on units shall be 15 inches deep.

Vertical sections shall be provided with both horizontal and vertical wireways. Sufficient clearances shall be provided in the horizontal wireway so that no restriction is encountered in running wires from the vertical to horizontal wireway. Wireways shall be in accordance with the wireways section contained in this document.

Horizontal Wireways: Horizontal wireways shall be provided in the top and bottom of each vertical section and shall be arranged to provide full length continuity throughout the entire assembly. The top horizontal wireway shall have a cross sectional area of not less than 20 square inches with openings between sections of not less than 11-1/2 square inches. The bottom horizontal wireway shall extend through the length and depth of the 11-1/2 square inches to allow for full length continuity throughout the entire assembly. The bottom horizontal wireway height shall be not less than 9-1/4 inches. Covers for all wireways shall be equipped with captive type screws to prevent loss of hardware during installation. All wireways shall be isolated from the bus bars.

Vertical Wireways: A vertical wire trough shall be located on the right-hand side of each vertical section and shall extend from the top horizontal wireway to the bottom of the available unit mounting space. Each vertical wire trough shall have a cross-sectional area of not less than 19 square inches and shall be isolated from the bus bars to guard against accidental contact. A separately hinged door having captive type screws shall cover the vertical wire trough to provide easy access to control wiring without disturbing the unit.

Reusable wire ties shall be furnished in each vertical wire trough for the purpose of grouping and securely holding wires in place for a neat and orderly installation.

Bus Bars: A continuous main 3-conductor horizontal bus shall be provided over the full length of the switchgear. When necessary, the bus shall be split to allow for ease in moving and handling. Splice bars will be supplied to join the bus whenever a split has been made. All splice connections shall be made with at least 2 bolts. Horizontal busbars shall be mounted edgewise and supported by insulated bus supports. Insulation shall be used as required by NEMA standards and shall be dated at no less than 600 VAC.

For distribution of power from the main horizontal bus to each unit compartment, a 3-phase vertical bus shall be provided. The vertical bus shall be firmly bolted to the horizontal bus for permanent contact.

The main horizontal and vertical buses shall be made of copper and the entire length shall be electrolytically tin plated to provide maximum protection to the bus bars from normal or adverse atmospheric conditions.

The main horizontal bus rating shall be a minimum 800 amperes continuous. Vertical bus rating shall be a minimum of 300 amperes for adequate current carrying capacity. Continuous current ratings shall be in accordance with temperature rise specifications set forth by UL, ANSI, and NEMA standards.

A copper ground lug shall be provided in each incoming line vertical section capable of accepting No.8 to 350 MCM cable. A horizontal (and vertical) tin plated copper ground bus shall be provided in each section of the switchgear. Horizontal ground bus shall run continuously throughout the switchgear except where splits are necessary for ease of shipment and handling in which case splice bars shall be provided. Ground bus shall be tin plated copper. Horizontal ground bus shall be located at

the bottom of the switchgear. Vertical ground bus shall run parallel to the power distribution bus in each vertical section. Design shall be such that for any plug-on unit the ground bus stab shall make contact with the ground bus before the power bus contact is made.

Bus Barriers: Insulated horizontal and vertical bus barriers shall be furnished to reduce the hazard of accidental contact with the bus. Barriers shall have a red color to indicate proximity of energized buses. Vertical bus barriers shall have interlocking front and back pieces to give added protection on all sides and shall segregate the phases to reduce the possibility of accidental "flash over." Small, separate openings in the vertical bus barriers shall permit unit plug-on contacts to pass through and engage the vertical bus bars. Bottom bus covers shall be provided below the vertical bus to protect the ends of the bus from accidental contact with fish tapes or other items entering from the bottom of the enclosure.

Controls and Meters: All new service panels shall be equipped with the following:

Kilowatt Meters. Type II, Class 3, Style B and shall have provisions for pulse initiation. Kilowatt meters shall be flush switchboard type as indicated on the drawings and shall be totally compatible to each particular application. Kilowatt meters shall be of one manufacturer, secondary type.

- The meters shall have an electronic demand register. The register shall be used to indicate maximum kilowatt demand as well as cumulative basis. It shall have provisions to be programmed to calculate demand on a rolling interval basis.

- The register shall be of modular design. The electronic module, containing all the program variables, shall be able to be easily removed from the mechanical register for programming, maintenance and trouble shooting.

- All electronic modules shall be physically identical and interchangeable.

- A frictionless optical assembly, mounted directly to the meter frame, generating 12 pulses per meter disc revolution for input to the electronic register shall be provided.

- Each kilowatt meter shall also be complete with a 5-dial mechanical kilowatt hour register.

- Meters shall be 3 stator, 120 volt for use on a wire Y, 3-phase system.

- Meter multiplier shall be shown on the face plate and shall be the product of the indicated current transformer and potential transformer ratio.

- Draw out arrangement for meter removal incorporating automatically short circuit current transformer circuits.

- Meter covers shall be polycarbonate resin.

- Meter detent to prevent negative registration by restricting the backward rotation of the disk.

- The normal billing data scroll shall be fully programmable. The following items shall be displayed in the data scroll:

  - Kilowatt hours
  - Maximum demand
  - Cumulative or continuously cumulative
  - Number of demand resets
  - Time remaining ı interval
  - End-of-interval indication
  - New maximum demand indication

- The register shall incorporate a built-in test mode that allows it to be tested without the need for any special tools or other accessories and saves data and constants before start of the test. The following quantities shall be available for display in the test mode:

    - Time remaining in demand interval
    - Present interval's accumulating demand
    - Maximum demand
    - Number of impulses being received by the register

- Pulse initiator with programmable ratio selection.

- Battery with battery port for quick changes.

- Meters shall be programmed after installation.

- Meters shall be tested, calibrated, and certified after installation.

- Self-monitoring to provide for stored data check sum error, ROM and RAM checksum error, battery fault, and unprogrammed register.

- Liquid crystal display, 9 digits, blinking squares confirm register operation. Large digits for data and smaller digits for display identifier.

- Display operations, programmable sequence with display identifiers. Display identifiers shall be selectable for each item. Continually sequence with time selectable for each item.

<u>Circuit Breakers</u>: Molded case circuit breakers shall be furnished in branch feeder units using circuit breakers as a disconnect means. All circuit breakers will have a push-to-trip test feature for testing and exercising the trip mechanism. Breakers shall be UL listed for a minimum of 22,000 amperes RMS symmetrical fault withstandability.

Main breakers (480 volt panels only) shall be equipped with auxiliary contacts and shunt trip coils. Optional electrical operation mechanisms shall be proposed for possible use if funding levels are adequate.

Identification: A control center identification nameplate with factory identification numbers and characteristics shall be fastened on the vertical wire trough door of every section. Each unit shall have its own identification nameplate fastened to the unit saddle. These nameplates shall have suitable references to factory records for efficient communication with supplier. Each unit shall also have an engraved nameplate fastened to the outside of the unit door for ease in identification and for making changes when regrouping units. Main breakers (480 panels only) shall be equipped with auxiliary monitoring contacts and shall be equipped with short trip controls. Optional electrical operations shall be proposed for possible use if funds are adequate.

Wiring: The switchgear wiring shall be NEMA Class II, Type B.

As defined by NEMA Standard ISC-2-322, Class II switchgear shall include the necessary electrical interlocking and interwiring between units.

Type B wiring shall include terminal blocks mounted on lift out brackets in the units.

Terminal blocks shall be quick separating pull-apart solderless box lug type or equal.

Finish: All metal structural and unit parts shall be completely painted using an electrodeposition process so that the interior and exterior surfaces as well as bolted joints have a complete finish coat on and between them.

3.0 TESTS

3.1 Following tests shall be performed and results recorded. All the equipment tests shall be performed in accordance with IEEE, NEMA, and ANSI Standards where such standards are definitive. All test data including but not limited to test circuitry, faulty equipment, and remedial action will be recorded, certified, correlated, bound, and furnished to the Owner.

a. Wiring continuity - point to point check and verification with the wiring diagrams.

b. Wiring insulation - check to ground - megger at 600 volts.

c. Power of proper amplitude and frequency shall be applied to all AC and DC circuitry. Three-phase potential and current of proper frequency shall be applied to all applicable AC connections.

d. Polarity tests of all AC and DC circuitry. Three-phase power and phase angle meter shall be used to make AC polarity test on power feeds and metering circuits.

e. Functional tests shall be performed on all equipment to indicate proper operation of all protection, metering, and control equipment. Power circuit breaker simulators shall be employed for the primary bus to verify proper operation of all equipment.

f. The Owner may at his option provide specific relay and metering test forms to be complied with, otherwise the Seller shall submit 2 copies of Seller's standard test forms for review by the Engineer.

g. All "as left" test values shall be recorded and shall be within manufacturer's tolerances. Manufacturer's tolerances shall be indicated on the test forms.

h. The intent of the acceptance test is to determine that the meters and relays have not sustained damaged during shipment from the manufacturer and that the meters and relay calibrations have not been disturbed. If the examination or test indicates that re-adjustment is necessary, the relay shall be repaired and/or calibrated as per manufacturer's instructions.

3.2 The Owner and/or Engineer may elect to visit the Seller's facilities on completion of fabrication of the equipment to inspect the equipment and witness testing as outlined in Section 3.1.

Appendix B

Test Reports

TRIP REPORT
FINAL ACCEPTANCE TESTING OF
ABB 112.5 KVA AMORPHOUS CORE TRANSFORMER
FOR SAN DIEGO NORTH ISLAND NAVAL BASE

Trip Date:	Jan. 15-17, 1991
Location:	Jefferson City, Missouri
Attendees:	J.S. Bertrand & S.A. McBride
Objective:	Attend witness testing of amorphous core transformer for the San Diego North Island Naval Base.

FACILITY:

ABB's Jefferson City Missouri distribution transformer manufacturing facility is comprised of engineering, administration, shipping & receiving, and manufacturing in a single 600,000 square foot facility. The plant has a high degree of modern automation, utilizing obotic welders, conveyers, painting apparatus, presses, et for a majority of the manufacturing. ABB uses an exte..sive Computer Aided Design And Manufacturing (CADAM) system to simplify the process of producing 200 to 300 transformers per day.

Factory Testing:

The f llowing transformer contracted with ABB is being manuf. ured by ABB in Jefferson City Missouri:

#	Order Number	Location	Size(kVA)	PWC#
1	V25E123YVY	473	112.5	CC48

The following sections will detail all testing performed on this unit. Engineering drawings and certified test data are attached to this report as available.

Tests:

1. Turns ratio, polarity, and phase rotation test
2. Demagnetization (exciting current)
3. Half wave & full wave impulse test
4. Applied voltage test of high voltage coils test
5. Applied voltage test of low voltage coils test
6. Induced voltage test (400Hz)
7. No-load loss test
8. Resistance, impedance, and load loss test
9. Temperature rise test

Shop Order #804001 Style #V2⌣E123YVY

This transform‹ was specified and constructed as a 112.5 kVA OA outdoor padmour.⌣ed unit. The transformer nas a 2400 volt delta primary winding and a 480/277 volt grounded wye secondary winding. The cooling fluid is 193 gallons of RTEmp (high molecular weight hydrocarbon). The following tests were performed on January 16-17, 1991 on the l'near test line as illustrated in the Electrical Testing Pro⌣ram--Jefferson City Booklet (PDL 46-300-TT-K Page 4-⁻ .

TEST	STATUS
Turns ratio test 8:00am	Failed. The first ratio test indicated that the secondary windings were improperly connected. This should have been identified during a preliminary ratio test which normally is performed prior to installation of the cooling oil. The transformer was removed from the test line and placed in the
11:00am	r pair area. The cooling fluid was then c.ained out of the tank to a leve. just below the top of the core/coil assembly. This would allow reconnection of the secondary windings. Extreme caution had to be used to avoid introducing any foreign objects into the tank during repair (such as bolts, nuts, washers, etc.). The root cause of the connection problems was determined to be that the wrong connection diagram was given to the internal construction team. The designer subsequently located the proper connection diagram and the connections were altered to the new configuration. The cooling fluid was
2:30pm	then very slowly reintroduced into the tank. Caution was used to minimize the introduction of air bubbles into the fluid. The transformer was then taken to the vacuum chamber where it was subjected to two complete vacuum cycles to draw any air from the transformer. The transformer was then brought back to the t st line.
4:30pm	A second ratio test was performed a⁻d passed. The polarity and phase rotation tests also passed.
Demagnetization 5:00pm	Passed. This test is performed to remove any residual magnetism in preparation for the impulse tests. It also serves as a means to measure the exciting current.

Impulse test 5:15pm	Each of the three high voltage windings was subjected to a half wave impulse test and a full wave impulse test. The test engineer tested the windings to 60 kV BIL. I reviewed the specification and informed him that the requirement was for 75 kV BIL. I stated that the 60 kV BIL test was not adequate and that they will be required to perform another test to the required 75 kV BIL. Based on the configuration of their test line it was not possible to go backwards and repeat the test. The unit would have to be reintroduced to the lineup following completion of the other tests. They assured that they would perform the impulse test to 75 kV BIL. I was contacted on January 22, 1991 and informed that the 75 kV BIL test had passed without incident. This plant does not have the capability to perform impulse testing of the low voltage windings. Therefore the 30 kV BIL tests of the 480 volt secondary windings were not performed.
Applied voltage	Both the high and low voltage tests passed.
Induced voltage	The 400 Hz induced voltage test passed.
No-load loss 6:00pm	The no-load loss was measured to be 86 watts. This value was 8 watts above the quoted value of 78 watts.
Load loss 6.15pm	The load loss was measured to be 1529 watts. This value was 29 watts below the quoted value of 1558 watts.
Resistance	Passed.
Impedance	The transformer impedance was measured to be 3.32%. This value is at the maximum limit of the specified impedance and is acceptable.
Temperature rise Jan. 17,1991 (24 hours)	54.5 degrees celsius

The tests on this unit were all performed with exclusion of the impulse testing on the secondary windings. During the tests several problems were identified. These items which require further attention are listed below:

ACTION ITEMS:

1. The transformer nameplate identified the unit as a 65 degree celsius rise. It should be 55 degree celsius rise.

2. The transformer nameplate identifies the transformer HV BIL as 60 kV. It should be 75 kV.

3. The transformer nameplate identifies the impedance as 2.76%. It was measured to be 3.32%.

4. Drawing J801R4Q shows item #12 (Pressure relief device, 350CFM at 15 psig) located on the front of the transformer inside the secondary compartment. This high volume pressure relief device which is required with the use of RTEmp fluid must be installed on the top of the unit (due to space limitations). I asked specifically what their intentions were and they informed that the required high volume PRD would be installed on one of the hand hole cover plates on top of the unit.

5. Jim Hankins will contact us with the proposed shipping information as soon as it is available.

6. ABB (Jim Hankins) will issue us a Certified Test Report as soon as it is available.

CONSLUSION:

The transformer passed an acceptable series of tests. The particular test series used by ABB is almost completely computer controlled. This makes it very difficult for the observer to know what is going on. Specific pass/fail criteria have been loaded into the computer system based on the experience of many thousands of successful units. Data from each of the tests are digitized and sent to the computer for analysis, the computer then either accepts the test results or rejects them. This application is designed for a volume production environment in lieu of a special/custom transformer environment. All things considered this is a very impressive manufacturing plant. Technology, personnel, design, and materials are for the most part outstanding.

ABB
ASEA BROWN BOVERI

ABB Power T&D Company Inc.
Underground Distribution Transformers
Jefferson City, MO 65101

PDL 46-300-TT-K

January 1990

Electrical Testing Program - Jefferson City

General Testing Program

Factory tests are performed on a transformer to confirm that it is properly designed and constructed to carry rated load and that it will withstand the conditions it will be exposed to in service. Factory tests are evidence of the reliability of a transformer, although the ultimate proof is trouble-free service over its expected li--

The Jefferson City :sting program is based on applicable ANSI, IEEE, and IEC standards and can be divided into 5 broad categories:

1. Test Data
   A. Test Parameters
   B. Test Results
2. Preliminary Tests
   A. Core Loss Test
   B. Turns Ratio Test
   C. First Preliminary Ratio Test
   D. Second Preliminary Ratio Test
3. Routine Tests
   A. Ratio
   B. Demagnetization
   C. Full Wave Impulse
   D. Applied Voltage Test of the HV Circuit
   E. Applied Voltage Test of the LV Circuit
   F. 400 HZ Induced Test
   G. No-Load Loss and Exciting Current
   H. Load Loss, Resistance and Impedance
   I. Final Continuity Check
   J. Circuit Breaker Test
4. Special Tests
   A. Sound
   B. Temperature
5. Calibration

1. Test Data

Test data consists of a set of test parameters and a set of test results for each individual transformer. Test data is ˙ed in the office mainframe computer. Test param- : are sent to the test floor and stored within the te computer system for later retrieval when the transformer arrives for testing. As transformers are tested, the results are held within the test floor computer system, then transferred to the mainframe.

A. TEST PARAMETERS

A unique set of parameters is used to test each individual transformer. This set is generated from a combination of three sources:

1. **Customer Specification**
   This includes all of the transformer ratings such as HV, LV, kVA, winding temperature rise, and frequency. The customer may specify special design tests such as sound, temperature rise, or RIV. He may require that the transformer be tested according to IEC standards or ANSI. If no-load loss, total loss, impedance, or exciting current is quoted to the customer, then 'not to exceed' values based on the quote are sent to the test floor as limits.

2. **Transformer Standards** (IEC, ANSI, IEEE, etc.)
   The standards specify the routine tests that must be performed on every transformer. Test voltage levels, test durations and pass/fail criteria are included. Examples are:

   400 HZ Induced Voltage level
   Full-wave Impulse Voltage
   Applied Voltage of the HV Circuit
   Applied Voltage of the LV Circuit

3. **Design Performance Criteria**
   If values such as no-load loss, total loss, impedance, and exciting current were not quoted to the customer, then values based on the design and/or past performance of the transformer style are sent to the test floor as pass/fail criteria. Examples are:

   400 HZ Induced Voltage Test Current Limit
   Minimum and Maximum % Impedance Limits
   No-load Losses and Exciting Current Limits
   HV and LV Coil Resistances
   Total Losses
   Load Losses

The Design Engineering Department may specify special design or "type" tests to verify new designs su n as chopped-wave impulse test, short circuit test, temperature test, sound or RIV.

B. TEST RESULTS
A set of test results is recorded for each transformer. Some of the values are sent directly to the customer when requested; examples are no-load loss, total loss, % impedance, % exciting current, and the formal notification that the transformer did receive and pass all required tests (Certified Test Report).

The test results are recorded in the design database to establish actual performance characteristics of new designs and to dynamically update performance characteristics of existing designs as materials vary and manufacturing processes are improved.

The test results are analyzed by the Quality Assurance Department to monitor, report trends, and take action as required to assure that quality manufacturing practices are followed.

2. Preliminary Tests

The preliminary tests are performed primarily to establish the acceptance of core/coil assembly. Four preliminary tests are performed:

A. CORE LOSS TEST
This test is performed on each core loop to measure the core loss at the (design) induction level. The cores are graded according to their measured losses, later combined as required to meet the no-load losses guaranteed for each complete core/coil assembly.

B. TURNS RATIO TEST
This test is performed as an audit of completed coils. It verifies that the number of turns is correct in each winding section.

C. FIRST PRELIMINARY RATIO TEST
The first preliminary ratio test is located in the core coil build area prior to the core coil bake oven. Ratio tests are performed on all core coil assemblies at the rated voltage connection and at all tap voltages. A small voltage (approximately 10 volts) is applied to the primary winding. The voltage applied and the secondary voltage are measured by a digital ratio meter. The meter divides the secondary voltage by the primary voltage and displays the ratio. For three phase transformers, the test is done separately on each phase.

D. SECOND PRELIMINARY RATIO TEST
A second preliminary ratio test is performed in the internal assembly area prior to vacuum oil fill. This ratio test is performed in the same manner as the first test, except that it is made with all bushings installed to verify that internal connections to the bushings are made with the correct polarity.

3. Routine Tests

Routine tests are performed on all transformers to verify that proper manufacturing practices were followed in the construction of each transformer and to establish performance characteristics. The following are routine tests:

- Ratio
- Demag
- Full Wave Impulse
- Applied Voltage Test of the HV Circuit
- Applied Voltage Test of the LV Circuit
- Induced Test
- No-load Loss and Exciting Current
- Load Loss and Impedance
- Final Continuity Check
- Circuit Breaker Test

A. RATIO TEST
The ratio test is given to verify that the transformer's ratio, polarity and phase rotation are correct.

Twenty volts is applied to the secondary terminals. The voltage applied and the induced primary voltage are measured and compared for ratio and phase relationship. The voltage is applied in three separate connection configurations for three phase units.

B. DEMAG TEST
The demag test is given to remove any residual magnetism in preparation for an impulse test. Also, it serves as a no-load exciting current test.

Power is applied to the low voltage windings. The voltage is ramped from zero to rated secondary voltage and then back to zero volts. A transformer is considered to have passed this test if the exciting current does not exceed the limit specified for the design of the transformer under test.

C. FULL WAVE IMPULSE TEST
The full wave impulse test attempts to simulate a lightning disturbance that travels some distance along a transmission line before it reaches the transformer. At the transformer, this wave shape rises from zero to crest in 1.2 microseconds and decays to one-half value in 50 microseconds. The peak value is specified by ANSI standards according to the transformer rating.

Each HV bushing is tested by impulsing that bushing while grounding one end of all windings and the tank. Each HV bushing receives an impulse shot at one-half the rated value and then another shot at the full impulse value. The ground current waveforms are recorded for both shots on a winding and compared. The current waveshape at the reduced impulse shot is taken first to establish the characteristic waveshape for the winding while the insulation is still considered to be sound. If the current waveshape of the full impulse shot is very similar to that of the reduced shot, the winding is considered to have passed the test.

D. APPLIED VOLTAGE TEST OF HV CIRCUIT (HLIC)
The HLIC test is performed to check the insulation design and to verify proper construction. The HLIC test verifies the major insulation between the HV circuit to the LV circuit and to ground. (The acronym "HLIC" stands for "high to low/iron continuity".)

The test is performed by connecting all HV terminals together and applying a specified voltage from the HV terminals to ground for one minute at 60 HZ while all other terminals and the tank are grounded. The voltage applied is specified by ANSI according to the transformer's ratings. A transformer is considered to have successfully passed the test if no appreciable current flows.

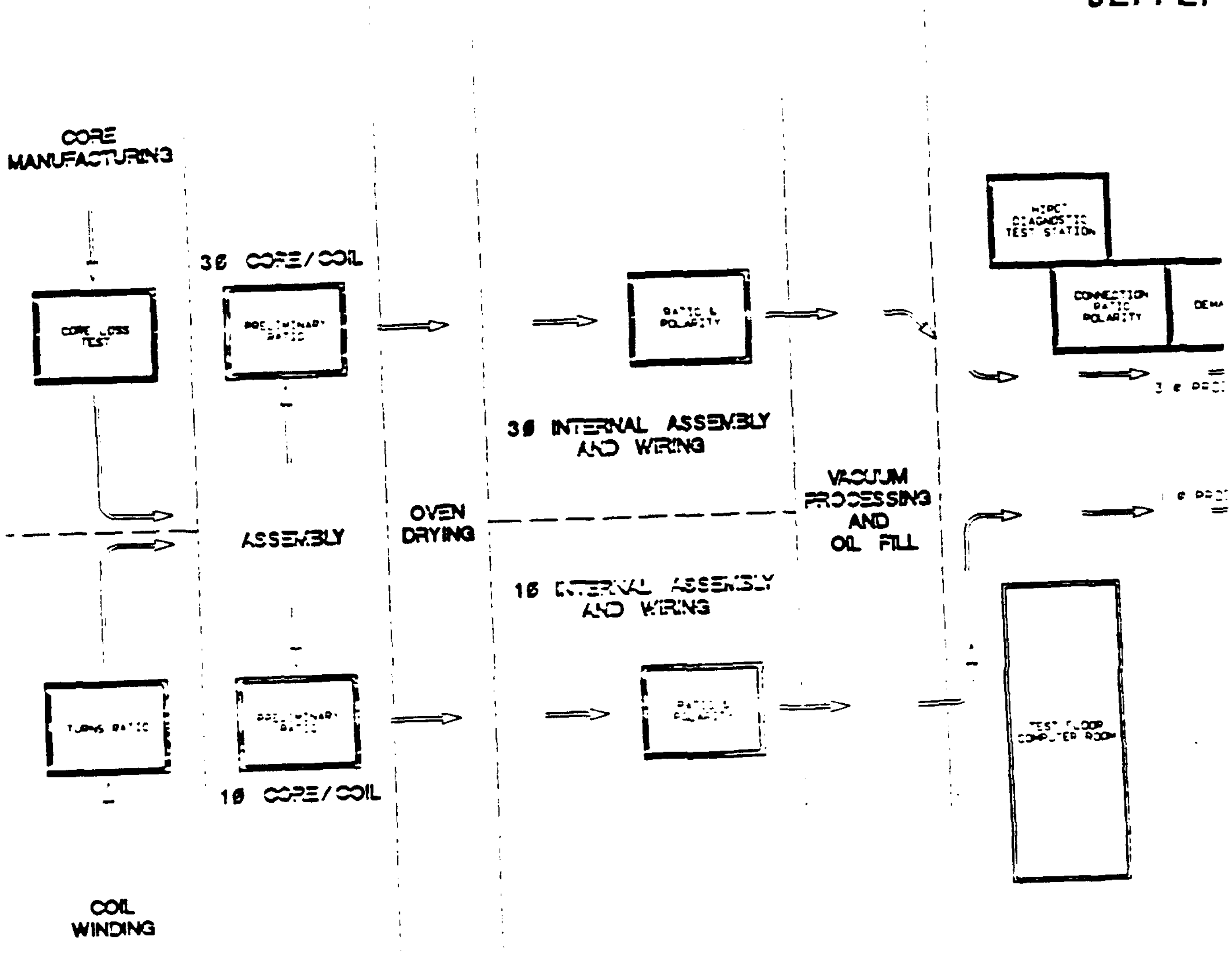
E. APPLIED VOLTAGE TEST OF LV WINDINGS (LHIC)
The LHIC test is also performed to check the insulation design and to verify proper construction. The LHIC test verifies the insulation between the LV circuit to the HV circuit and to ground. (The acronym "LHIC" stands for "low to high/iron continuity".)

The test is performed by connecting all LV terminals together and applying a specified voltage from the LV terminals to ground for one minute at 60 HZ while all other terminals and the tank are grounded. The voltage applied is specified by ANSI according to the transformer ratings. A transformer is considered to have successfully passed the test if no appreciable current flows through the transformer.

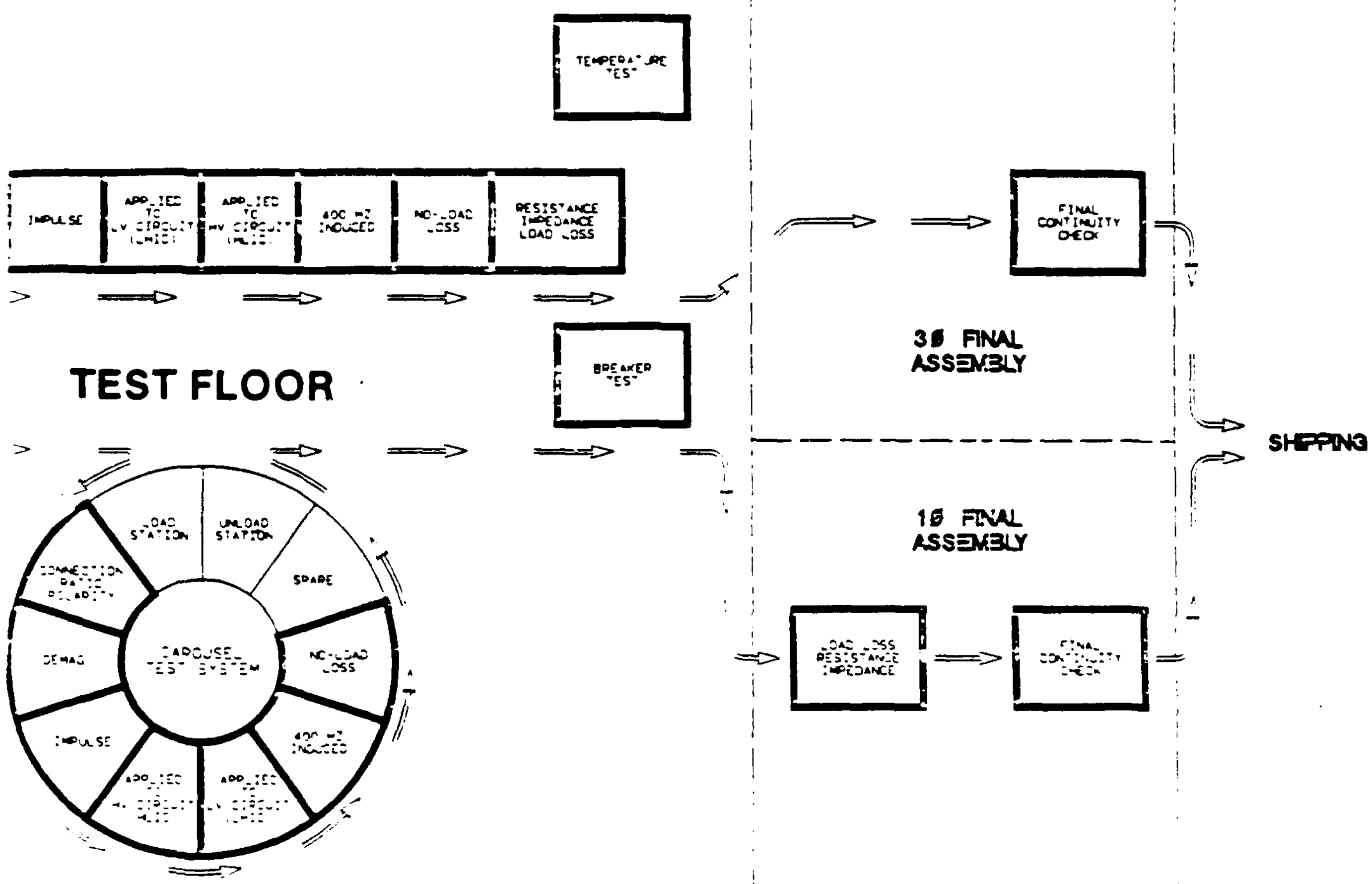
F. 400 HZ INDUCED POTENTIAL TEST
The 400 HZ test is performed on all transformers to check insulation design and verify proper construction. Although this test also verifies the major insulation between the HV and LV circuits, its main purpose is to check the turn-to-turn and layer-to-layer insulation within the HV and LV windings. Also, this test checks the insulation between phases in the HV and LV circuits.

A 400 HZ voltage is applied to the low voltage terminals for eighteen seconds. The voltage can be from two to four times rated (determined by the transformer ratings according to ANSI standards). The transformer is considered to have successfully completed this test if the current does not exceed a calculated value, based on the transformer's design.

JEFFEF


CORE MANUFACTURING
CORE LOSS TEST
3Ø CORE/COIL
PRELIMINARY RATIO
ASSEMBLY
OVEN DRYING
RATIO & POLARITY
3Ø INTERNAL ASSEMBLY AND WIRING
VACUUM PROCESSING AND OIL FILL
TEST STATION
CONNECTION RATIO POLARITY
1Ø INTERNAL ASSEMBLY AND WIRING
TURNS RATIO
PRELIMINARY RATIO
1Ø CORE/COIL
TEST FLOOR COMPUTER ROOM
COIL WINDING

ON CITY TRANSFORMERS
LECTRICAL TESTS



G NO LOAD LOSS AND EXCITING CURRENT

The no-load losses are losses of a transformer excited at rated voltage but not supplying load: that is, when only exciting current flows through the energized winding. The no-load loss consists of the iron loss in the core, dielectric loss, and the loss in the windings due to the exciting current.

Rated voltage is applied to the low voltage terminals with the high voltage terminals open circuited. Simultaneous readings are made of voltage applied, power input, and excitation current.

The no-load loss TW (true watts) is the value read by a wattmeter measuring the power input. The % excitation current is the percent of rated current drawn during this test.

The no-load loss AW (apparent watts) is the product of the applied voltage and the exciting current (also, times the square root of 3 if a three phase transformer).

H. LOAD LOSS, RESISTANCE AND IMPEDANCE TEST

The load loss of a transformer is the loss created by current flow through the transformer windings. Current flow through the windings creates the following two types of losses:

a. I^2R loss. The I^2R loss is the real power consumed (or heat created) by load current passing through the winding resistance.

b. Stray loss. The stray loss is the eddy current losses caused by leakage flux. The stray loss is generally less than five percent of total losses.

The impedance voltage is the voltage drop due to load current passing through the inductance and resistance of the windings. The impedance is expressed as a percentage of rated high voltage.

The test is performed by shorting the LV bushings together and applying sufficient excitation to the HV bushings to circulate rated current through the HV circuit. Measurements are taken for power input, voltage applied, current, and oil temperature. Winding resistances are measured. Then, the impedance and load loss are calculated at the rated operating temperature (normally 85° C).

I FINAL CONTINUITY CHECK

A continuity test is performed on all transformers. This test will assure our customers that the transformer fulfills their specifications and prevent possible safety hazards due to incorrectly wired transformers.

The continuity test is performed in Final Assembly **after** all HV, LV and accessory markings (stencils, decals, etc.) have been applied to the transformer. The following checks are made:

a. The nameplate is compared to manufacturing information for style, serial number, kVA, HV rating, LV rating, tap voltages, impedance, conductor materials and coil BIL rating.

b. The quantity of bushings, electrical accessories, and fuses on the unit is verified to agree with the nameplate and manufacturing information. The bushing identification on the unit is checked against the nameplate.

c. An ohmmeter is then used to check the unit and verify that the internal wiring and the operation of all devices (breakers, switches, pull-out fuses, etc.) agrees with the nameplate.

J CIRCUIT BREAKER TEST

Each transformer that has an under-oil breaker is routed to the breaker test station. There, each p[illegible] of the breaker is tested by circulating s[illegible]ent current to trip the breaker within twenty seconds. This is an operational test which assures that the breaker was correctly installed and is mechanically and electrically sound.

4. Special Tests

Special tests are performed at the option of the customer or the design engineer.

A. SOUND TESTING

Some customers specify a maximum allowable transformer sound level. The sound generated by a transformer is affected by the core geometry, flux density, tank design, and the quality of assembly of all of the transformer component into a completed unit.

Sound measurements are made on the "A" weighted scale. The "A" characteristic best relates how a young listener (with normal hearing) hears the complex transformer-generated sound. For reference, zero dB is a sound level just barely below the minimum detectable sound level of the "young listener". The noise level in a large office usually is between 50 and 60 dB. Very loud sounds such as nearby airplanes and railroad trains may exceed 100 dB.

Sound level tests require an ambient sound level at least five, and preferably ten, decibels lower than the sound level of the transformer and ambient combined. The tests are performed in the shipping warehouse and are scheduled during off-shifts to obtain the lowest practical ambient sound level (approximately 36 dB). Sound tests are made with the unit powered at 100% and 110% of rated voltage under no-load conditions.

Sound measurements are made at three-foot intervals on a stretched string contour around the tank at half the tank height. The points begin at the drain valve and proceed clockwise around the tank. The sound instrument nozzle is pointed horizontally at the string with the end of the instrument one foot from the string.

The measurement values are averaged to obtain an average "A" weighted sound level.

B. TEMPERATURE TESTS

Core losses and coil losses are the primary sources of heating within the transformer. Temperatures within the transformers are a function of:

a. Losses generated by the core and coil
b. Core, coil and tank construction
c. The transformer's external environment (primarily the surrounding air temperature)

In general, our transformers are guaranteed to have an average coil winding temperature of no more than 65°C rise over ambient air temperature when operated at rated voltage and load conditions. (Other winding temperature rises may be specified.)

The temperature test is performed to determine the thermal characteristics of the transformer and to verify that these characteristics are within design limits.

The Compromise Method (or Short Circuit Loading Method) is used to simulate rated operating conditions. The low voltage winding terminals are shorted and sufficient current is circulated through the HV windings to generate a loss within the transformer equivalent to the core loss plus the load loss. The transformer tap changer is connected to its maximum loss (lowest voltage) position and total losses are applied to the transformer.

Total Loss = Iron Loss + Load Loss

The purpose of this initial loading is to establish the maximum oil rise temperature of the transformer. Thermocouples are used to monitor the top and bottom oil temperatures and the ambient air temperatures. The transformer is operated at this loading until the increase in the oil temperature over ambient does not change more than 1°C in three hours.

After a three-hour period of stable oil temperature, the loading is cut back to rated current and continued for one hour. The transformer is then disconnected from the power source. Immediately, resistance measurements are taken as the transformer cools. The initial resistance readings on each winding are taken within four minutes after the transformer is de-energized. Three additional readings are taken, up to a maximum time of ten minutes after the transformer was de-energized.

The resistance of a winding prior to de-energizing the transformer can be found by plotting the resistance readings versus time and extrapolating the curve back to zero time. Knowing the resistance, the winding temperature at the instant of shutdown can be calculated. Following are useful performance data obtained from the temperature test:

Avg. Oil Rise = (Top Oil @ Cutback + Bottom Oil @ Cutback) ÷ 2

Coil Diff. = Winding Rise - Top Oil Rise

Top Oil Rise = Top Oil @ Cutback - Amb. @ Cutback

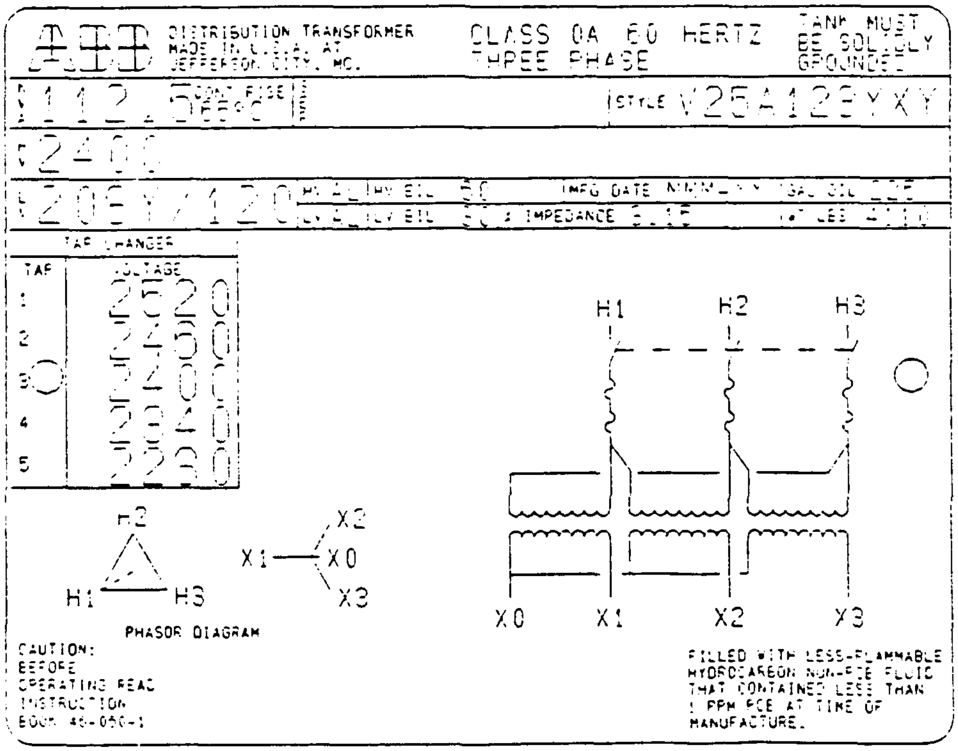
Gradient = Winding Rise - Avg. Oil Rise

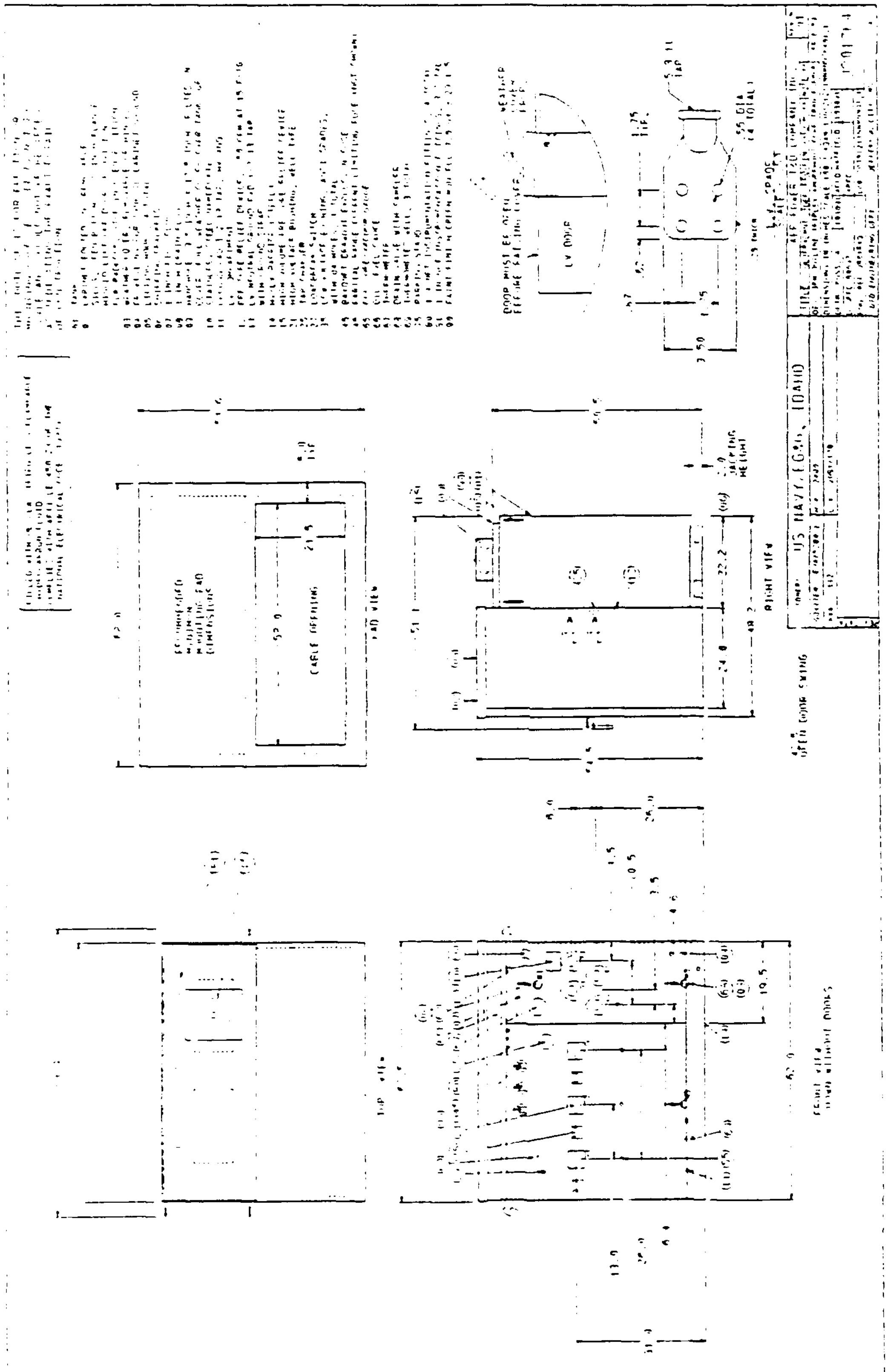
Winding Rise = Wind. Temp - Ambient @ Cutback + (Top Oil @ Cutback - Top Oil @ Shutdown)

5. Calibration

The test equipment is periodically calibrated to assure that the tests are valid and accurate.

More detailed information about the calibration program is in the Electrical Calibration Procedure, QAP302.


DISTRIBUTION TRANSFORMER
MADE IN U.S.A. AT
JEFFERSON CITY, MO.
CLASS OA 60 HERTZ
THREE PHASE
TANK MUST BE SOLIDLY GROUNDED
112.5
STYLE V25A123YXY
2400
208Y/120
HV BIL
LV BIL
MFG DATE
% IMPEDANCE
TAP CHANGER
TAP
VOLTAGE
1 2520
2 2460
3 2400
4 2340
5 2280
H1
H2
H3
X0
X1
X2
X3
PHASOR DIAGRAM
CAUTION:
BEFORE
OPERATING READ
INSTRUCTION
BOOK 46-050-1
FILLED WITH LESS-FLAMMABLE
HYDROCARBON NON-PCB FLUID
THAT CONTAINED LESS THAN
1 PPM PCB AT TIME OF
MANUFACTURE.


CABLE OPENING
RIGHT VIEW
TOP VIEW

TRANSMITTAL
FORM 34576D

SEND APPROVALS OR INQUIRIES TO:

ABB POWER T&D COMPANY INC.
1101 CROSSROADS PARKWAY NORTH, STE. 220
CITY OF INDUSTRY, CA 91746

TRANSMITTAL DATE

S.C. NO.	PROD. CODE	ATTN: ORDER SERVICE REP. PAT DEL VILLAR	CUST. ORDER NO. LS-01528-C	G.O. NO. & C/N DATE EJA15280-RJ3

TO
EG&G IDAHO INC
BOX 1625 1455 FREMONT AVE.
IDAHO FALLS, ID 83415

ULTIMATE USE AND/OR MARKINGS
SAN DIEGO NAVAL BASE

11/10/92
NOV 0 4 1992

__ FOR APPROVAL TO MAINTAIN SHIPPING SCHEDULE, APPROVED DWGS. MUST BE RECEIVED BY ABB ON
DRAWINGS ARE IN COMPLIANCE WITH YOUR SPECIFIED REQUIREMENTS. DRAWINGS "APPROVED" OR "APPROVED WITH MODIFICATIONS" AUTHORIZE ABB TO PROCEED WITH THE MANUFACTURE. MODIFICATIONS NOT IN THE CONTRACT OR MODIFICATIONS MADE DURING OR AFTER DRAWING APPROVAL MAY RESULT IN A PRICE CHANGE AND/OR SHIPMENT DELAY.

X FOR CONSTRUCTION OR INSTALLATION
THE EQUIPMENT SHOWN ON THESE DRAWING(S) HAS BEEN RELEASED FOR MANUFACTURE. ANY MODIFICATION MAY RESULT IN PRICE CHANGE OR SHIPMENT DELAY.

RPD APPROVAL BY:

DRAWINGS APPROVAL STD./SKETCH	PAPER REPRO	CONSTRUCTION OR INSTALL PAPER	REPRO	INST. BOOKS BND.	UN-BND.	RPD STD.	REC. PRICED	TEST REPORTS	SPECIFIC CUSTOMER INSTRUCTIONS ARE DETAILED IN NOTES TYPE OF REPRO * — MAIL DWGS. TO
		10		3					EG&G IDAHO INC ABOVE ADDR. ATTN: ~~BOB ...~~ SCOTT MCBRIDE REF: EG&G IDAHO INC, P.O. #C90-131706 SAN DIEGO NAVAL BASE/PROJECT 015341
		1		1					LANDGRAF, GIERKE & ASSOC 5011 ARGOSY AVE., STE 17 HUNTINGTON BEACH, CA. 92649 ATTN: TROY KELTNER
		1T/S							ABB CITY OF INDUSTRY ATTN: P.A. DEL VILLAR
T/S	T/S	T/S	T/S	T/S	T/S	T/S		T/S	T/S

	QTY	DESCRIPTION
1	1	112.5 KVA Transformer, Style V25A123XXY, 3801ZK4 Outline, Nameplate per style

DWG. NO.	SUB	DRAWING TITLE	DWG. NO.	SUB	DRAWING

THIS TRANSMITTAL IS Y COMPLETE
__ PARTIAL WITH DRAWINGS NOTED ABOVE OR ON ATTACHED SHEET TO BE SENT BY J.C. Mehta.

A B B POWER T & D COMPANY, INC.
DISTRIBUTION TRANSFORMER DIVISION

CERTIFIED TRANSFORMER TEST INFORMATION BY STYLE.

FOR: INDUSTRIAL & CONSTRUCTION

PHASE	HERTZ	KVA	LOW VOLTAGE	HIGH VOLTAGE
3PH	60	112.5	208Y/120	2400

LOSSES ARE REPORTED AT 100 PERCENT OF RATED VOLTAGE.
NO LOAD LOSSES REPORTED AT 85 DEG. C AND LOAD LOSSES AT 85 DEG. C.

CUST. PO. LS 01528 C
CUST.ID.

ABB PO/ITM EJA15280 1
ABB STYLE V25A123YXY

SERIAL NUMBER	NO LOAD	LOAD	TOTAL	PERCENT IMPED.	EXCITING CURRENT	REGULATION AT 80%	REGULATION AT 100%	SHIP DATE	INVOICE NUMBER
91J033082	72.9	1421.3	1494.2	3.00	.56	2.65	1.30	**/**/**	
REPORT AVERAGE	72.9	1421.3	1494.2	3.00	.56	2.65	1.30		
QUOTED LOSSES									

TOTAL UNITS 1

RISE OF WINDINGS BY RESISTANCE AT 65 DEG. C. GUARANTEED.

--------------- INSULATION TESTS ---------------

IMPULSE TEST: 60 KV FULL WAVE IMPULSE TEST APPLIED TO THE HIGH VOLTAGE

APPLIED POTENTIAL TESTS:	VOLTAGE RATING	TEST VOLTAGE APPLIED IN KV	TESTS SECONDS
HIGH VOLTAGE WINDING:	2400	19	60
LOW VOLTAGE WINDING:	208	10	60

INDUCED POTENTIAL TEST: 2.0 TIMES THE RATED VOLTAGE ACROSS FULL WINDING APPLIED FOR 18 SECONDS AT 400 HERTZ ,UNITS RATIO AND POLARITY TESTED.

WE CERTIFY THAT THE ABOVE INFORMATION IS A TRUE REPORT BASED ON FACTORY TESTS MADE IN ACCORDANCE WITH THE LATEST TRANSFORMER TEST CODE OF THE AMERICAN NATIONAL STANDARDS INSTITUTE, AND THAT THE ABOVE TRANSFORMERS WITHSTOOD THESE TESTS.

TRIP REPORT
FINAL ACCEPTANCE TESTING OF
NATIONAL INDUSTRI CAST COIL TRANSFORMERS
FOR SAN DIEGO NORTH ISLAND NAVAL BASE

Trip Date: Oct. 8-11, 1990
Location: Hampton VA
Objective: Attend witness testing of cast coil transformers for the San Diego North Island Naval Base.

Factory Testing:

The following eight transformers contracted with ABB are being manufactured by ABB/National Industri Transformer Inc. in Hampton, VA:

#	Shop Order	Location	Size(kVA)	PWC #
1	2897	94	750/1000	CC69
2	2898	94	300	CC70
3	2899	378-1	750/1000	CC27A
4	2900	378-1	500	CC27B
5	2901	472	1500	CC45
6	2902	489	1500	CC49
7*	2903	342	112.5	CC16
8	2904	378-6	500	CC26

* Shop order # 2903 had not been constructed at the time of this trip. It is scheduled to be completed in late November.

The following sections will detail all testing performed on each of the transformers. The certified testing reports issued by National Industri are included in the appendix of this trip report should you need further information.

Tests:

1. Coil resistance test
2. Turns ratio test
3. Polarity & phase rotation
4. No-load loss
5. Impedance & load loss
6. Temperature rise test
7. Impulse (BIL) test
8. Applied potential test
9. Induced potential test
10. Partial discharge test

Shop Order #2897:

This transformer is a 750/1000 kVA AA/FA outdoor unit substation complete with a 15kV fused primary switch and secondary switchgear. The transformer has a 2400V/12000V reconnectable primary winding and a 480/277V secondary winding. Each primary winding is constructed using five sections. These five sections are connected in series for the 12000V configuration and in parallel for the 2400V configuration. Vertical busses mounted external to the coils are used to make the series/parallel connections. High voltage taps are provided on the primary 12000V configuration only. The primary switch was built in as part of the unit. The secondary switchgear was not present. It is assumed that ABB will be supplying this switchgear themselves. Note that the transformers are painted a non-standard color and that the secondary switchgear will need to be painted to match. The tests performed on this unit and the results were as follows:

TEST	STATUS
Coil Resistance	See test sheet.
Turns Ratio Test	See test sheet.
Pol. & Ph. Rotat.	Tests okay.
No-load Loss	Measured no-load losses = 2491 watts. This is substantially less than the guaranteed maximum of 2800 watts.
Load Loss	Measured load losses = 5728 watts. This is slightly over the guaranteed maximum of 5700 watts, however, it is within the +/- 5% tolerance required in the RFP.
Impedance	Measured to be 5.21%--this value is within tolerance of 5% (+/- 10% dual voltage only).
Temperature Rise	AA measured (celsius) Max 73.1 FA measured (celsius) Max 68.3 These values are within the required 80 degree C maximum. Note that the transformer failed the first FA heat run test, however, passed the second attempt.
Impulse Test	All impulse tests passed. However, problems were encountered on the H3 coil. The second chopped wave test on H3 failed. Several modifications to the test connections were performed of which none solved the problem. Finally it was determined that the clearance between the fan blade and the primary coil was not sufficient. For 95kV BIL, a minimum of 5.5 inches is needed. The fan blade was

approximately 2.5 inches from the primary coil. The fan appeared not to be damaged by the failures. See narrative for further discussion.

Applied Potential	Passed, no problems detected
Induced Potential	Passed, no problems detected
Partial Discharge	The partial discharge tests were performed using new equipment in the "Corona Room". The levels of detected partial discharges were recorded for both 110% and 150% of rated primary voltage at both the top and bottom of each high voltage coil. The levels monitored contain a substantial amount of background noise and therefore and not completely indicative of the actual level of partial discharge in the coil. The transformer was determined to pass the test in lieu of the misleading results obtained.

The transformer successfully passed all tests, however, several problems were experienced during the process. The load loss was measured to be 28 watts over the guaranteed maximum of 5700. However, the no-load loss was measured substantially under the guaranteed maximum. The end result is a lower total loss over what was guaranteed. This transformer required four heat runs, AA (ambient air) 2400V, FA (forced air) 2400V, AA 12000V, and FA 12000V. Both of the AA heat runs passed without incident, however, the FA heat runs failed. The transformer had been designed and constructed with 6 cooling fans. Prior to temperature testing, the design engineer had determined that this design would not be sufficient and that 12 fans would be required to maintain adequate cooling. The design engineer then issued an "Engineering Change Notice ECN" to change the design. This ECN was not executed prior to testing the transformer. The transformer was then modified to incorporate the 12 fan design. The FA heat tests were rerun and passed successfully. This modification caused another problem. When the additional 6 fans were installed the clearance between the fan blades and the high voltage bus was reduced from 6 inches to 2.5 inches. This spacing proved inadequate as the 95kV impulse tests failed. It turned out that another ECN had been drafted and not implemented. The design engineer had proposed a bussing modification which would allow adequate spacing of 5.5 inches. We performed the bussing modifications in the impulse bay and were able to pass all impulse tests without further incident. The final problem encountered while testing this unit was during the partial discharge testing. The "corona room" is used to perform partial discharge testing. The large transformers however will not fit in their corona room, thus, accurate isolated testing is not possible. The result is a substantial amount of noise overlayed on the partial discharge display (lissajous figure). No problems with the transformer were detected during this testing, however, they are in the process of upgrading their test equipment so that more accurate testing can be performed.

Shop Order #2898

This transformer is a 300kVA indoor padmount unit with a 480V delta primary winding and a 208/120V grounded wye secondary. The following tests were performed on this unit.

TEST	STATUS
Coil Resistance	See test sheet.
Turns Ratio Test	See test sheet.
Pol. & Ph. Rot.	Tests okay.
No-load Loss	The measured no-load loss = 1318 watts. This is under the guaranteed maximum of 1400 watts.
Load Loss	The measured load loss = 3200 watts. This is over the guaranteed maximum of 3100 watts.
Impedance	The impedance was measured to be 3.16%. This is within tolerance.
Temperature Rise	AA measured (celsius) maximum 49.3
Impulse Test	All tests passed at 30kV.
Applied Potential	Passed, no problems detected
Induced Potential	Passed, no problems detected
Partial Discharge	This transformer had to be partial discharge tested in the transformer test bay #1. No problems were detected.

Overall, all tests passed and no problems were identified. The clearances in the unit are very tight, however, the unit passed all 30kV impulse tests so the spacing proved to be adequate.

Shop Order #2899

This transformer is a 750/1000kVA AA/FA indoor unit substation complete with a new 15kV fused primary switch and new secondary switchgear. The transformer has a 12kV delta connected primary and a 480/277V grounded wye secondary.

No tests were witnessed on this unit. I have reviewed the certified test report for this unit and no problems were identified. The losses, impedance, temperature rise, and configuration is within specification. Refer to the appendix for further information.

Shop Order #2900

This transformer is a 500kVA AA indoor padmount. It has a 480V delta connected primary and a 208/120V grounded wye connected secondary. The transformer has a very high primary current and such no primary voltage taps are required. The primary winding is wound as two sections connected in parallel to supply the high current required. The tests performed on this unit were as follows:

TEST	STATUS
Coil Resistance	See test sheet.
Turns Ratio Test	See test sheet.
Pol. & Ph. Rot.	Tests okay.
No-Load Loss	The measured no-load loss = 1483 watts. This is less than the guaranteed maximum of 1600 watts.
Load Loss	The measured load loss = 6204 watts. This is greater than the guaranteed maximum of 5900 watts. This value is 9 watts over the +/- 5% tolerance level.
Impedance	The measured impedance = 6.22%. This value is slightly over the tolerance value.
Temperature Rise	AA measured (celsius) maximum = 54.5
Impulse Test	All tests passed at 30kV.
Applied Potential	Passed, no problems detected.
Induced Potential	Passed, no problems detected.
Partial Discharge	This transformer had to be partial discharge tested in transformer test bay #1. No problems were detected.

All factory tests passed. Note that a stripped out insulator on the primary bus was detected and replaced. During the impulse testing intermittent problems were encountered while testing the H3 terminal. Nothing was found out of order with the transformer. The test gear was reset then the tests were rerun and each test passed without incident. The problem was thus assumed to be in the test equipment.

Shop Order #2901

This transformer is a 1500kVA outdoor retrofit padmount unit. It has a 12000V delta primary and a 480/277V secondary. The following tests were performed on this unit:

TEST	STATUS
Coil Resistance	See test sheet.
Turns Ratio Test	See test sheet.
Pol. & Ph. Rot.	Tests okay.
No-Load Loss	The measured no-load loss = 3689 watts. This is below the guaranteed maximum of 3900 watts.
Load loss	The measured load loss = 9441 watts. this is below the guaranteed maximum of 9600 watts.
Impedance	The measured impedance = 5.6%. This is within tolerance.
Temperature Rise	AA temperature (celsius) maximum = 67.4
Impulse Test	Passed, no problems detected.
Applied Potential	Passed, no problems detected.
Induced Potential	Passed, no problems detected.
Partial Discharge	This transformer had an uncharacteristically good response under the partial discharge test. No problems were detected.

All tests on this unit went well. No problems were identified.

Shop Order #2902

This transformer is a 1500kVA outdoor retrofit padmount unit. It has a 12000V delta connected primary and a 480/277V grounded wye secondary. It will be installed to replace a temporary 3750kVA unit substation. The existing primary switch will be re-installed. The following tests were performed on this unit:

TEST	STATUS
Coil Resistance	See test sheet.
Turns Ratio Test	See test sheet.
Pos. & Ph. Rot.	Tests okay.

No-Load Loss	The measured no-load loss = 3759 watts. This value is below the guaranteed maximum of 3900 watts.
Load loss	The measured load loss = 9429 watts. This value is below the guaranteed maximum of 9600 watts.
Impedance	The measured impedance = 5.77%. Within tolerance.
Temperature Rise	Not received yet.
Impulse Test	Passed, no problems detected.
Applied Potential	Passed, no problems detected.
Induced Potential	Passed, no problems detected.
Partial Discharge	Passed.

The tests were all performed, however, the certified test report has not been received. The report was inadvertently not placed in the transmittal package. The test results presented for this unit were taken directly from my field notes. The temperature rise information is not available as I did not witness the overnight temperature rise tests. The data will be reviewed when the certified test report is received. Two of the high voltage bus sections have very sharp edges. These edges cause very high stress regions on the bus bars. I recommended that they grind the edges smooth to eliminate this problem. They agreed that it could cause a problem and stated that they would eliminate the sharp edges. Several problems were observed while performing the partial discharge tests. A majority of the problems were corrected by removing the buswork and adjusting the test apparatus connections to the coils. It was determined that no problems existed in the transformer coils. Removal of the sharp edges should eliminate a majority of the remaining problems.

Shop Order #2903

This unit has not been built. It is scheduled for construction by late November. No tests were performed on this unit.

Shop Order #2904

This transformer is a 500kVA outdoor padmount unit. It has a 12000V delta primary and a 4[illegible]/277V secondary. The following tests were performed on this unit:

TEST	STATUS
Coil Resistance	See test sheet.
Turns Ratio Test	See test sheet.
Pol. & Ph. Rot.	Tests okay.
No-Load Loss	The measured no-load loss = 2244 watts. This is under the guaranteed maximum of 2400 watts.
Load Loss	The measured load loss = 4499 watts. This is under the guaranteed maximum of 4700 watts.
Impedance	The measured impedance = 5.57%. This is within tolerance.
Temperature Rise	Not received yet.
Impulse Test	All tests passed.
Applied Potential	Passed, no problems detected.
Induced Potential	Passed, no problems detected.
Partial Discharge	Passed.

The tests were all performed, however, the certified test report has not been received. The report will be sent with the one for unit #2902. The data will be reviewed when the report is received. Note that this unit did not have future forced air fan mounting brackets. These brackets should be added prior to shipping from National Industri. They informed me that the brackets would be added. We will want to follow up in the field and verify that they did get installed.

CONCLUSION:

The tests went well in spite of several challenges. Transformers #2897 through 2904 except #2903 are ready for installation. Unit #2903 will be completed in late november.

EB NATIONAL INDUSTRI
2520 58th Street
Hampton, Virginia 23661
Telephone (804) 838-8080
Telex 82-3646
Telefax (804) 838-8905

TRANSMITTAL LETTER

FOR

CERTIFIED TEST REPORT

RE: ABB SERVICE CO.
2382 E. ARTESIA BLVD.
LONG BEACH, CA 90805

DATE: OCT 16

SHOP ORDER NO: 28970

ATTENTION: ROGER RATICAN

JOB NAME: TBA

CUSTOMER: ABB SERVICE CO

P.O.NO: LS-01446-C

We are transmitting herewith four (4) copies of the Certified Test Report for your records.

If you have any questions, please do not hesitate to contact me.

Sincerely,

Patty Dorris

Patty Dorris
Admin. Assist. Mkt.

PARTIAL DISCHARGE TEST DATA

SHOP ORDER 02897-1
STYLE NO. 840750B057
KVA 750
TEST DATE OCTOBER 9, 1990

TOP	% VOLTAGE	COIL 1	COIL 2	COIL 3
INCEPTION	150	40 pc	20 pc	20 pc
EXTINCTION	110	5 pc	10 pc	10 pc

BOTTOM	% VOLTAGE	COIL 1	COIL 2	COIL 3
INCEPTION	150	10 pc	20 pc	50 pc
EXTINCTION	110	3 pc	10 pc	15 pc

EB NATIONAL INDUSTRI

2520 58th Street
Hampton, Virginia 23661

Telephone
(804) 838-8080

Telex
82-3646

Telefax
(804) 838-8905

TRANSMITTAL LETTER

FOR

CERTIFIED TEST REPORT

RE: ABB SERVICE CO.
2382 E. ARTESIA BLVD.
LONG BEACH, CA 90805

DATE: OCT 16 19..

SHOP ORDER NO: 28970

ATTENTION: ROGER RATICAN

JOB NAME: TBA

CUSTOMER: ABB SERVICE CO

P.O.NO: LS-01446-C

We are transmitting herewith four (4) copies of the Certified Test Report for your records.

If you have any questions, please do not hesitate to contact me.

Sincerely,

Patty Dorris

Patty Dorris
Admin. Assist. Mkt.

EB NATIONAL INDUSTRI

CERTIFIED TEST REPORT

HOP ORDER 02897-1 STYLE NO. 840750B057 TEST DATE 10-09-90

OMINAL VOLTAGE: 12000 Delta / 480 Grd-Wye Three Phase 60 Hertz
VA: 750/1000 CLASS: AA/FA AVG WDG RISE: 75 DEG C.
NSULATION RATED AT 185 DEGREE C BIL (kv): HV- 95 LV- 30

USTOMER: ABB SERVICE CO. PO# LS-01446-C
LONG BEACH, CA. 90805

KVA	NO LOAD LOSSES 24 C (watts)	% Iex 24 C	TAP (volts)	LOAD LOSSES 95 C (watts)	% Z 95 C	TOTAL SERIES RESISTANCE @ 95 C PRIMARY (ohms)	SECONDARY (ohms)
750	2491	0.906	12000	5728	5.21	7.02239	0.002762

APPLIED VOLTAGE HV (kv)	LV (kv)	INDUCED VOLTAGE 400 Hz, 18 SEC. (volts)	NOMINAL RATIO	
34	4	960	A/B	43.405
			C/A	43.391
			B/C	43.392

NSI STANDARD IMPULSE TEST PERFORMED AT 95 KV BIL.

A MEASURED TEMPERATURE RISE (C): HV - 73.1 LV - 60.8

A MEASURED TEMPERATURE RISE (C): HV - 68.3 LV - 51.1

MPEDANCE AND LOAD LOSSES AT TAPS:
1-2) = 5.10% AND 5445 WATTS, (5-6) = 5.28% AND 5787 WATTS.
ARTIAL DISCHARGE TEST PERFORMED, SEE ATTACHED FOR TEST RESULTS.
OWER FACTOR TEST PERFORMED AT 2.5 KV:
-G = .747, L-G = .350 AND H-L = .436

ERTIFICATION:

EST TECHNICIAN Leo Adams ENGINEER Beth A Jasinski

NATIONAL INDUSTRI TRANSFORMERS, INC.
HAMPTON, VA. 23661

PARTIAL DISCHARGE TEST DATA

SHOP ORDER 02897-1
STYLE NO. 840750B057
KVA 750
TEST DATE OCTOBER 9, 1990

TOP	% VOLTAGE	COIL 1	COIL 2	COIL 3
INCEPTION	150	40 pc	20 pc	20 pc
EXTINCTION	110	5 pc	10 pc	10 pc

BOTTOM	% VOLTAGE	COIL 1	COIL 2	COIL 3
INCEPTION	150	10 pc	20 pc	50 pc
EXTINCTION	110	3 pc	10 pc	15 pc

NATIONAL INDUSTRI
TRANSFORMERS, INC.

Hampton, VA 23661
804-838-8080
Telex 82-3646

ISSUED 9-1-79
REVISED 12-9/83
SECTION B-7

TRANSFORMER IMPULSE TEST REPORT

Purchaser [illegible] Electric Co.

Date of Test 10/10/90 Purchaser's Order No. LS-01[illegible] Mfr's. Ref. [illegible]

Type Cast/core Phase 3 Hertz 60 Insulating Fluid

H Winding 750 KVA X Winding 750 KVA Y Winding KVA

12000 DELTA Volts 480GRDY/277 Volts Volts

95KV BIL 30 KV BIL BIL

Serial No.	Terminal Surged	Test*	Crest Voltage KV	Wave Shape or Rate of Rise	Time to Flashover	Oscillogram Number	Sweep Time or Timing Wave Freq. μ Sec.	Conn. of Unim. Term.
897-1	H-1	RFWV	47.5	1.25/49μs		1	10	Ground Term.
		RFWC				1c	10	Current Shunt
		CWV	95		2.40μs	2	2	
		CWV	95		3.60μs	3	2	
		FWV	95	1.25/49μs		4	10	
		FWC				4c	10	
	H-2	RFWV	47.5	1.25/49		5	10	
		RFWC				5c	10	
		CWV	95		1.90μs	6	2	
		CWV	95		1.80μs	7	2	
		FWV	95	1.25/49		8	10	
		FWC				8c	10	
	H-3	RFWV	47.5	1.25/49μs		9	10	
		RFWC				9c	10	
		CWV	95		1.80μs	10	2	
		CWV	95		1.85μs	11	2	
		FWV	95	1.25/49μs		12	10	
		FWC				12c	10	

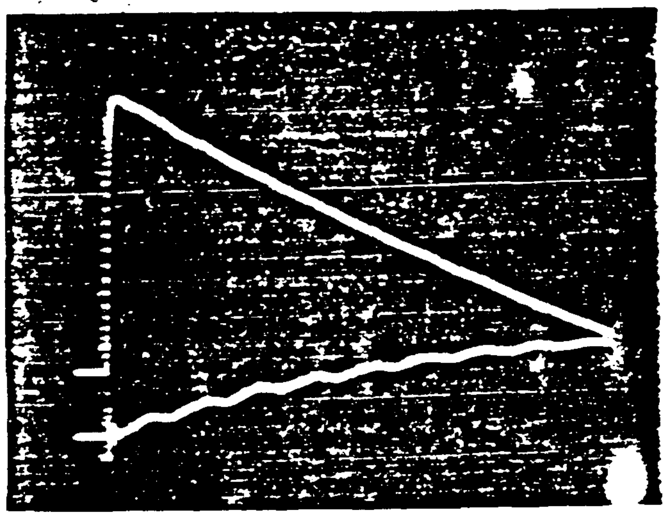
* RFWV Reduced Full-Wave Voltage. RFWC Reduced Full-Wave Current. FWV Full-Wave Voltage. FWC Full-Wave Current. CWV Chopped-Wave Voltage. FCWV Front of Wave Voltage.

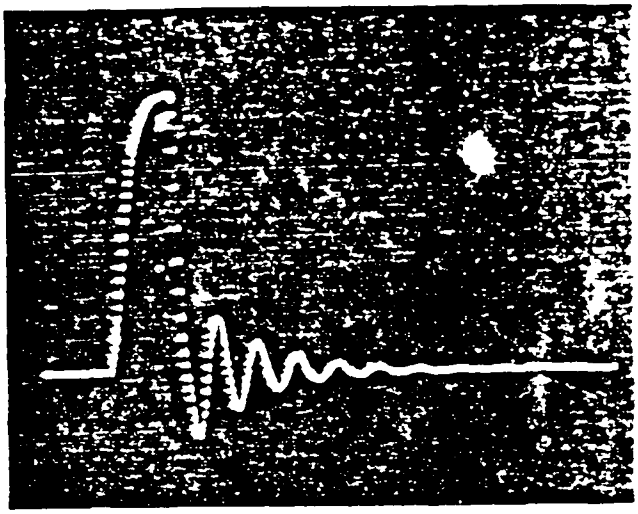
GRD Terminals grounded. ARR Terminals connected to arresters. RES Terminals connected to ground through linear resistance.

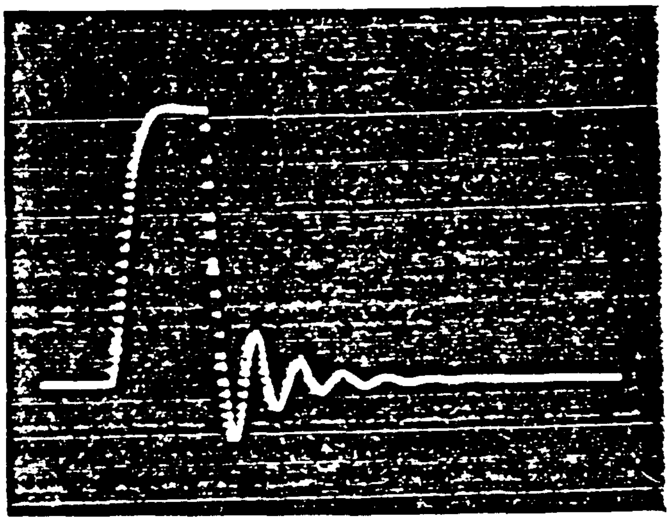
Tests Witnessed by Scott McBride (FCHC)

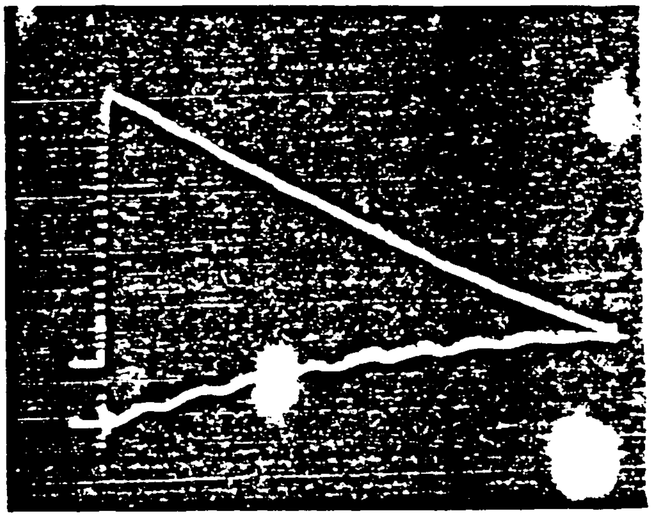
I hereby certify that this is a true report based on factory tests made in accordance with USA Standard Test Code for Distribution, Power and Regulating Transformers, C57.12 or latest revision thereof; and that each transformer withstood the above tests.

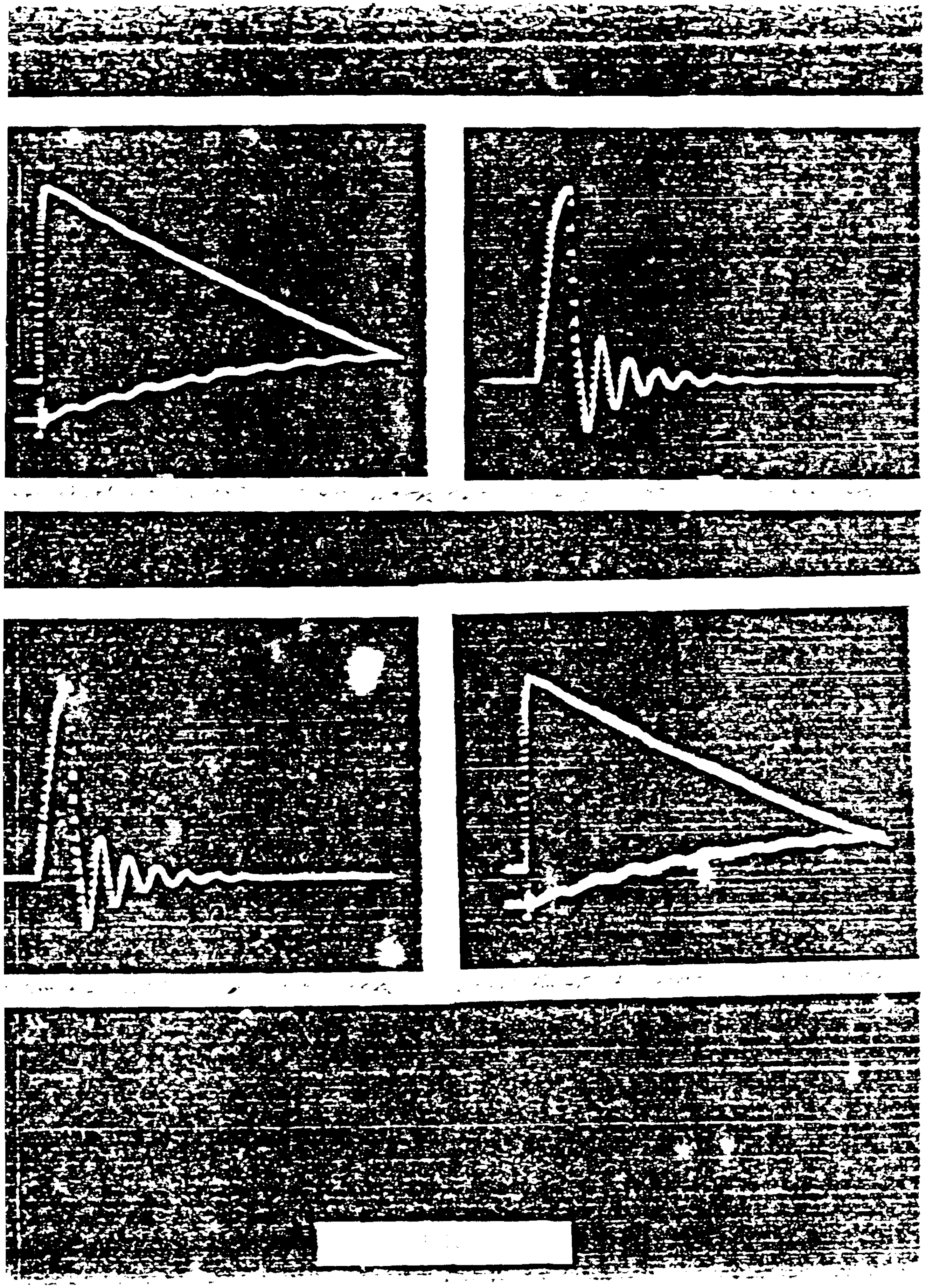
Signed [illegible] Date 10/10/90 Approved [illegible]

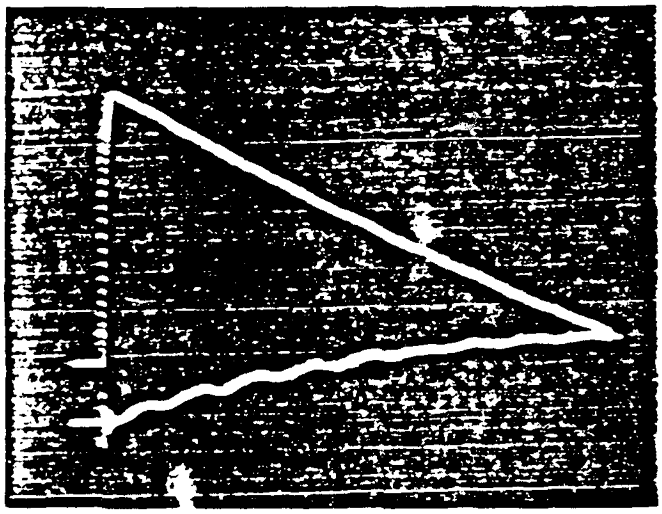


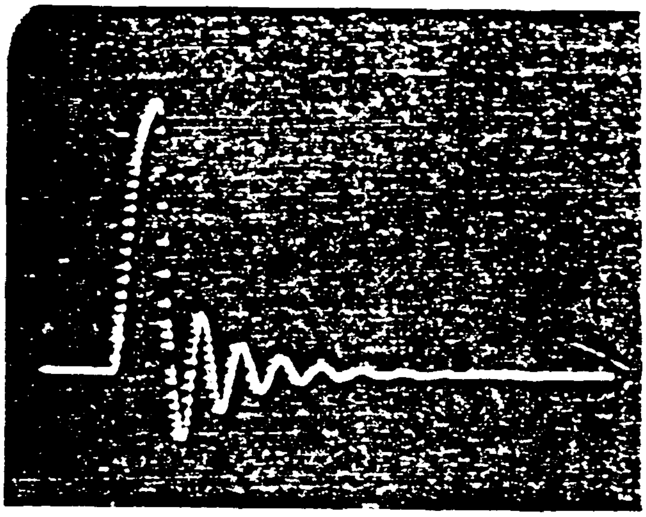


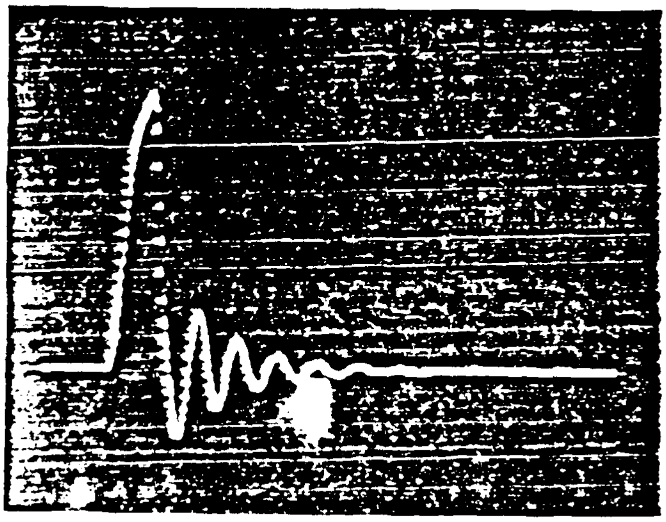


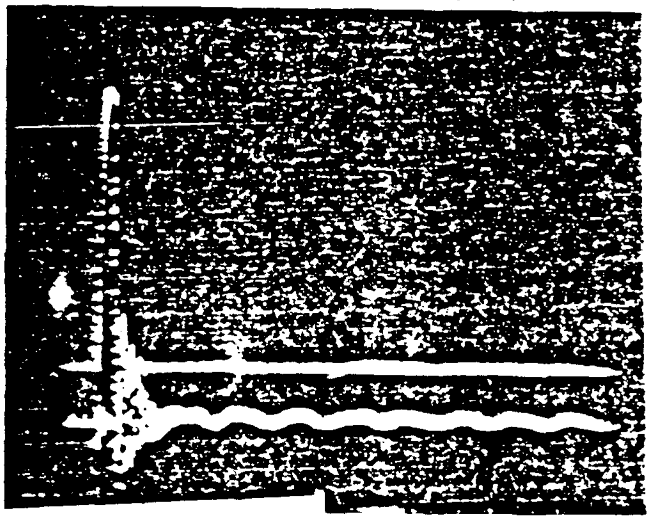


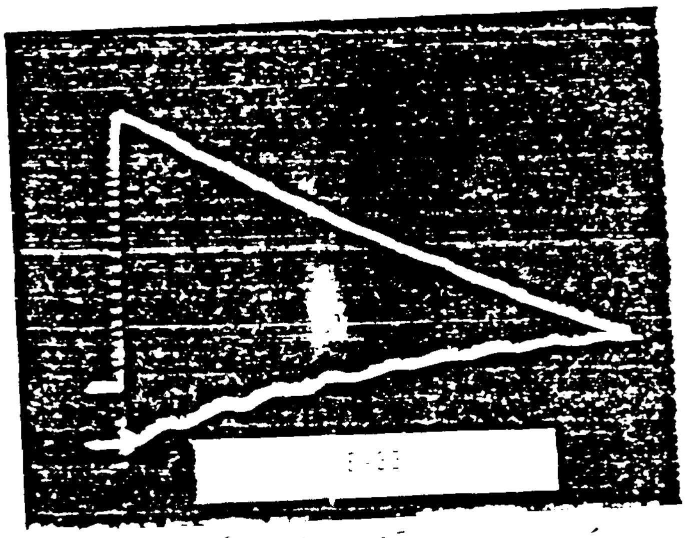












TRANSFORMER IMPULSE TEST REPORT

Purchaser: AEP SERVICE Co.

Date of Test: 10/9/90 Purchaser's Order No. LS-01446-C Mfr's. Ref. [illegible]

Type: CAST/CAST Phase: 3 Hertz: 60 Insulating Fluid:

H Winding: 750 KVA X Winding: 750 KVA Y Winding: ____ KVA

2400 DELTA Volts 480Y/277 Volts ____ Volts

30K BIL 30K BIL ____ BIL

Terminal No.	Terminal Surged	Test*	Crest Voltage KV	Wave Shape of Rate of Rise	Time to Flashover	Oscillogram Number	Sweep Time or Timing Wave Freq. N Sec.	Connection of Unused Windings Terminals
-1f	H-1	RFWV	15	1.33/59µs		1	10	Grounded Through
		RFWC				1c	10	Current Shunt
		CWV	30		1.35µs	2	2	
		CWV	30		1.35µs	3	2	
		FWV	30	1.33/59µs		4	10	
		FWC				4c	10	
	H-2	RFWV	15	1.33/59µs		5	10	
		RFWC				5c	10	
		CWV	30		1.50µs	6	2	
		CWV	30		1.50µs	7	2	
		FWV	30	1.33/59µs		8	10	
		FWC				8c	10	
	H-3	RFWV	15	1.33/59µs		9	10	
		RFWC				9c	10	
		CWV	30		1.35µs	10	2	
		CWV	30		1.45µs	11	2	
		FWV	30	1.33/59µs		12	10	
		F..				12c	[illegible]	

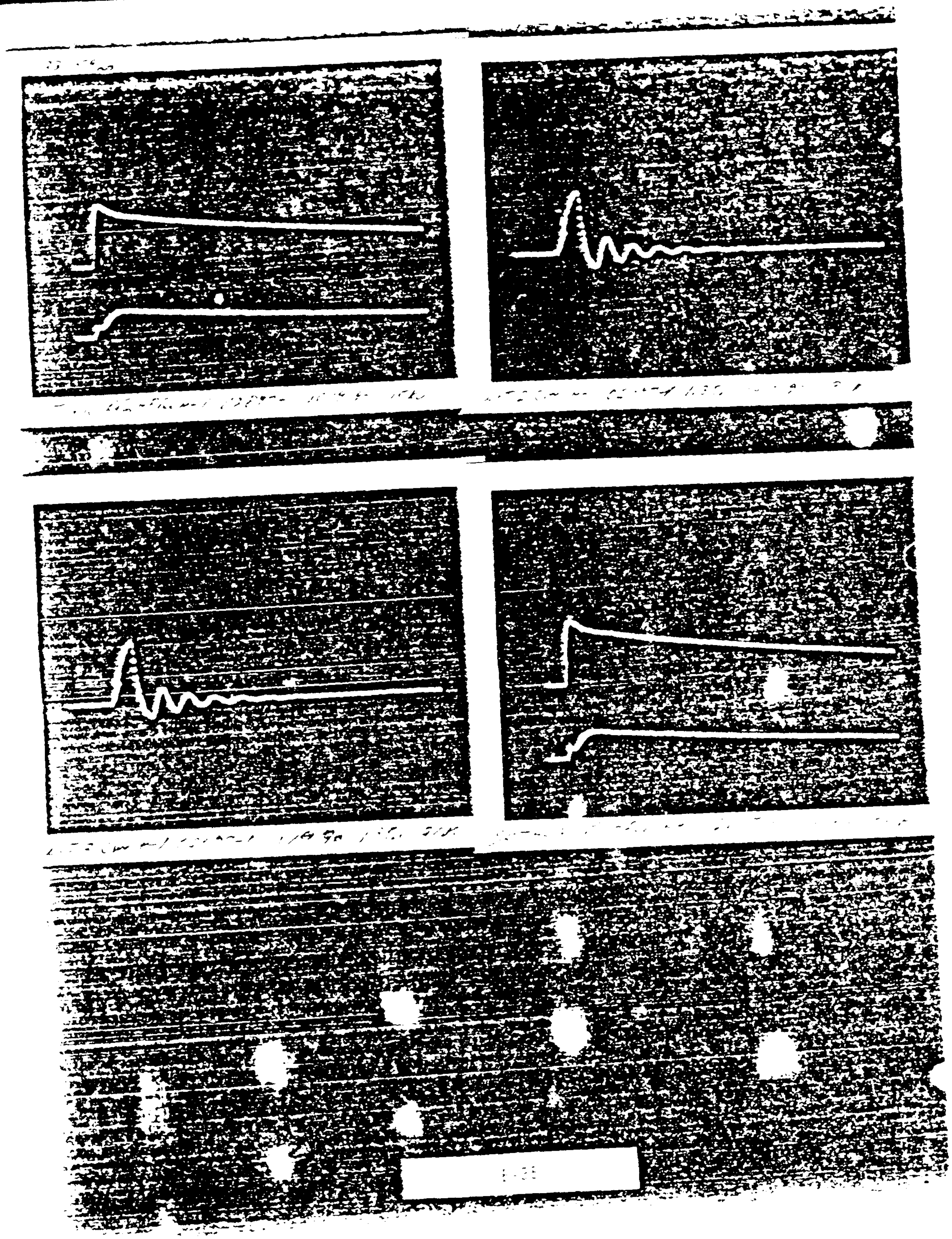
* RFWV Reduced Full-Wave Voltage, RFWC Reduced Full-Wave Current, FWV Full-Wave Voltage, FWC Full-Wave Current, CWV Chopped-Wave Voltage, FOWV Front of Wave Voltage.

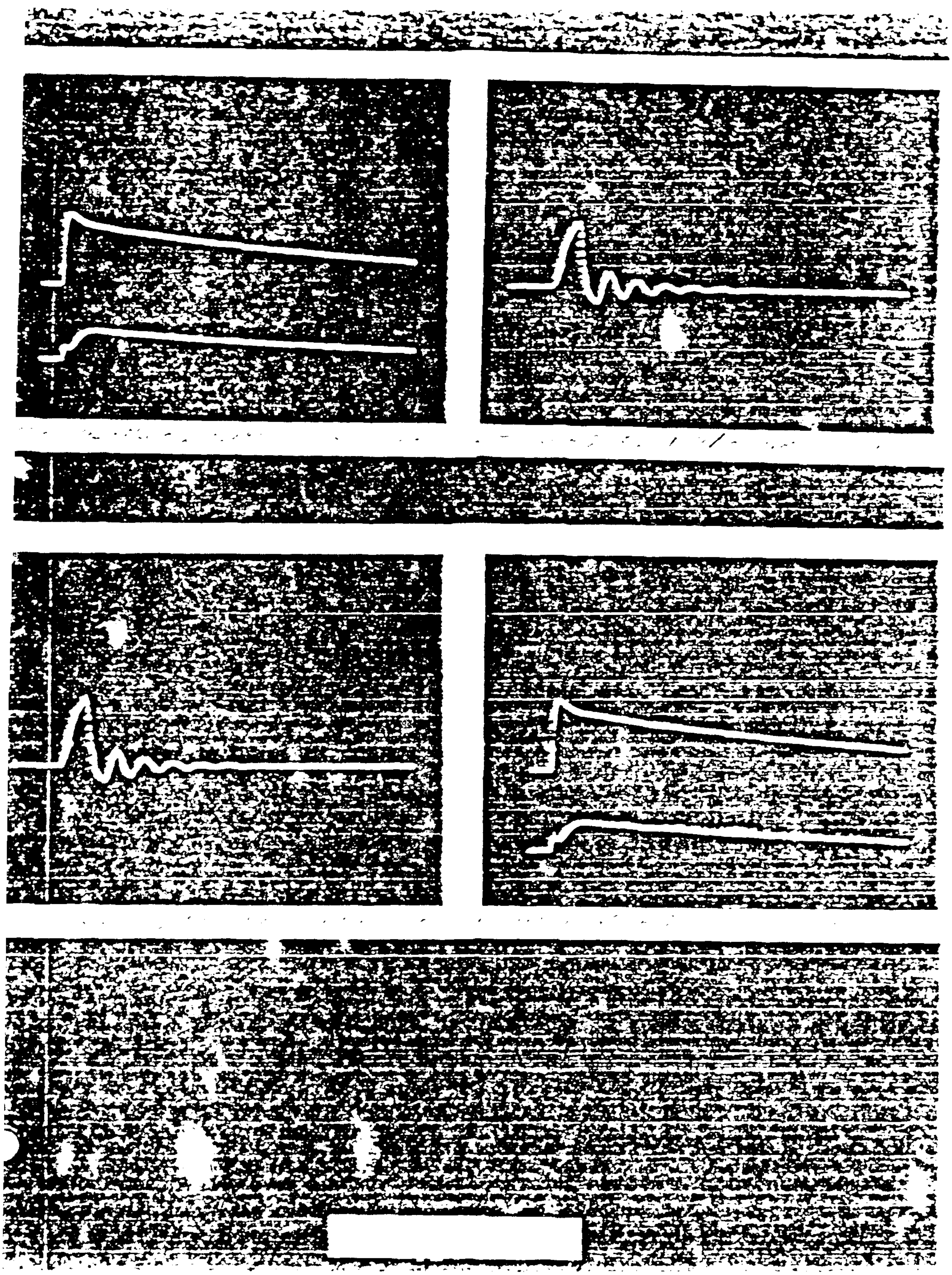
GRD Terminals grounded, ARR Terminals connected to arresters, RES Terminals connected to ground through linear resistance.

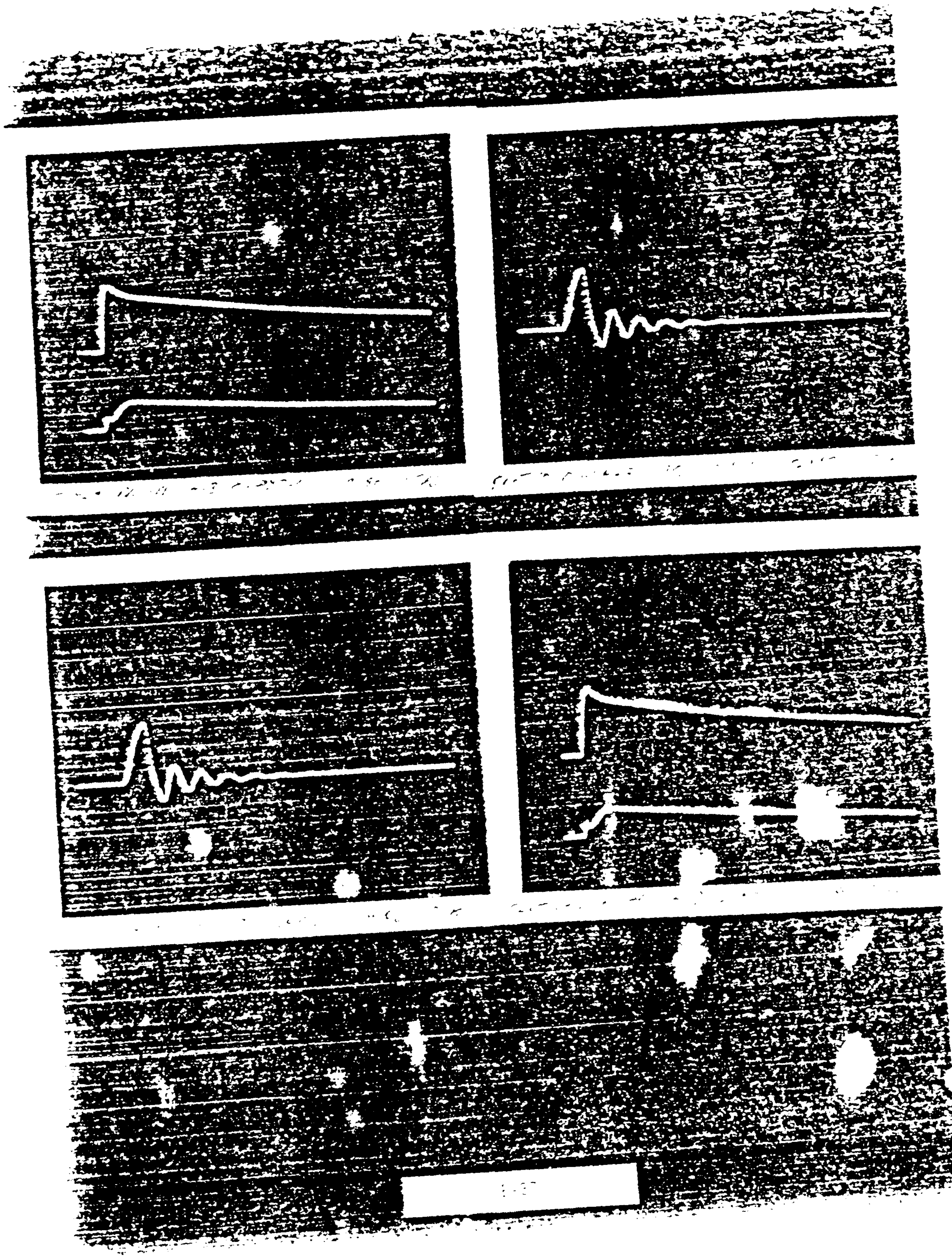
Tests Witnessed by: Scott McBride (SGHG)

I hereby certify that this is a true report based on factory tests made in accordance with USA Standard Test Code for Distribution, Power and Regulating Transformers, C57.12 or latest revision thereof; and that each transformer withstood the above tests.

Signed: [signature] Date: 10/10/90 Approved: [signature]







EB NATIONAL INDUSTRI

2520 58th Street
Hampton, Virginia 23661

Telephone
(804) 838-8080

Telex
82-3646

Telefax
(804) 838-8905

TRANSMITTAL LETTER

FOR

CERTIFIED TEST REPORT

RE: ABB SERVICE CO.
2382 E. ARTESIA BLVD.
LONG BEACH, CA 90805

DATE: OCT 1[illegible] [illegible]

SHOP ORDER NO: 28980

ATTENTION: ROGER RATICAN

JOB NAME: TBA

CUSTOMER: ABB SERVICE CO

P.O.NO: LS-01446-C

We are transmitting herewith four (4) copies of the Certified Test Report for your records.

If you have any questions, please do not hesitate to contact me.

Sincerely,

Patty Dorris

Patty Dorris
Admin. Assist. Mkt.

EB NATIONAL INDUSTRI

* CERTIFIED TEST REPORT *

SHOP ORDER 02898-1 STYLE NO. 810300B001 TEST DATE 10-08-90

NOMINAL VOLTAGE: 480 Delta / 208 Grd-Wye Three Phase 60 Hertz
KVA: 300 CLASS: AA AVG WDG RISE: 65 DEG C.
INSULATION RATED AT 185 DEGREE C BIL (kv): HV- 30 LV- 30

CUSTOMER: ABB SERVICE CO. PO# LS-01446-C
LONG BEACH, CA 90805

KVA	NO LOAD LOSSES 28 C (watts)	% Iex 28 C	TAP (volts)	LOAD LOSSES 85 C (watts)	% Z 85 C	TOTAL SERIES RESISTANCE @ 85 C PRIMARY (ohms)	SECONDARY (ohms)
300	1318	1.692	480	3200	3.16	0.03365	0.001662

APPLIED VOLTAGE HV (kv)	LV (kv)	INDUCED VOLTAGE 400 Hz, 18 SEC. (volts)	NOMINAL RATIO	
12	4	416	A/B	3.994
			C/A	3.993
			B/C	3.992

ANSI STANDARD IMPULSE TEST PERFORMED AT 30 KV BIL.

AA MEASURED TEMPERATURE RISE (C): HV - 49.3 LV - 48.9

IMPEDANCE AND LOAD LOSSES AT TAPS:
(1-2) = 3.05% AND 2720 WATTS, (5-6) = 3.18% AND 3282 WATTS.
PARTIAL DISCHARGE TEST PERFORMED, SEE ATTACHED FOR TEST RESULTS.
POWER FACTOR TEST PERFORMED AT 2.5 KV:
H-G = .379, L-G = .539 AND H-L = .292

CERTIFICATION:

TEST TECHNICIAN Leon Adam ENGINEER Beth J. [illegible]

NATIONAL INDUSTRI TRANSFORMERS, INC.
HAMPTON, VA. 23661

ABB
ASEA BROWN BOVERI

EB CORPORATION - A MEMBER OF THE ASEA BROWN BOVERI GROUP

PARTIAL DISCHARGE TEST DATA

SHOP ORDER 02898-1
STYLE NO. 810300B001
KVA 300
TEST DATE OCTOBER 8, 1990

TOP	% VOLTAGE	COIL 1	COIL 2	COIL 3
INCEPTION	150	32 pc	35 pc	32 pc

BOTTOM	% VOLTAGE	COIL 1	COIL 2	COIL 3
INCEPTION	150	35 pc	35 pc	31 pc

NATIONAL INDUSTRI

TRANSFORMERS, INC.

4520 ... Street
Hampton, VA 23661
804) 838-8080
Telex 82-3646

ISSUED 9/7/79
REVISED 12/9/8
SECTION B-7

TRANSFORMER IMPULSE TEST REPORT

Purchaser: [illegible] Service Co.

Date of Test: 1/15/9[illegible] Purchaser's Order No. LS-[illegible]-C Mfr's. Ref. [illegible]

Type: [illegible] Phase: 3 Hertz: 60 Insulating Fluid: ______

H Winding: 300 KVA X Winding: 300 KVA Y Winding: ______ KVA

480 DELTA Volts 208GRDY/120 Volts ______ Volts

30 kv BIL 30 kv BIL ______ BIL

Serial No.	Terminal Surged	Test*	Crest Voltage KV	Wave Shape or Rate of Rise	Time to Flashover	Oscillogram Number	Sweep Time or Timing Wave Freq. N Sec.	Cor...
02598-1	H-1	RFW	15	1.50/47μs		1	10	Grom...
		RFWC				1c	10	Curr...
		CW	30		1.55μs	2	2	
		CW	30		1.35μs	3	2	
		FW	30	1.50/47μs		4	10	
		FWC				4c	10	
	H-2	RFW	15	1.50/47μs		5	10	
		RFWC				5c	10	
		CW	30		1.65μs	6	2	
		CW	30		1.40μs	7	2	
		FW	30	1.50/47μs		8	10	
		FWC				8c	10	
	H-3	RFW	15	1.50/47μs		9	10	
		RFWC				9c	10	
		CW	30		1.50μs	10	2	
		CW	30		1.40μs	11	2	
		FW	30	1.50/47μs		12	10	
		FWC				12c	10	

* RFWV Reduced Full-Wave Voltage. RFWC Reduced Full-Wave Current. FWV Full-Wave Voltage. FWC Full-Wave Current. CWV Chopped-Wave Voltage. FOWV Front of Wave Voltage.

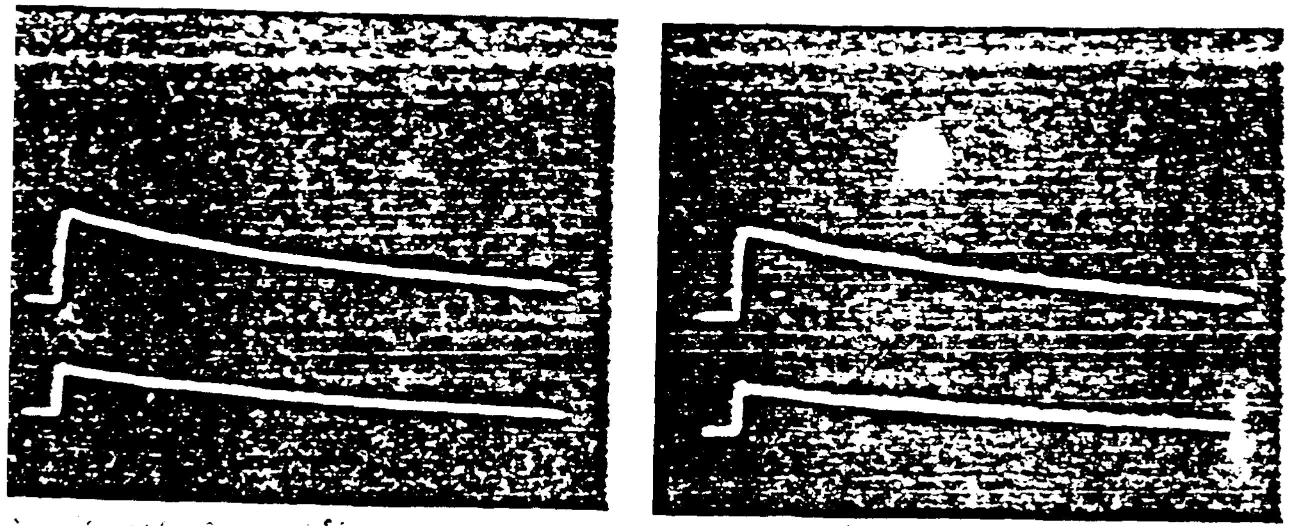
GRD Terminals grounded. ARR Terminals connected to arresters. RES Terminals connected to ground through linear resistance.

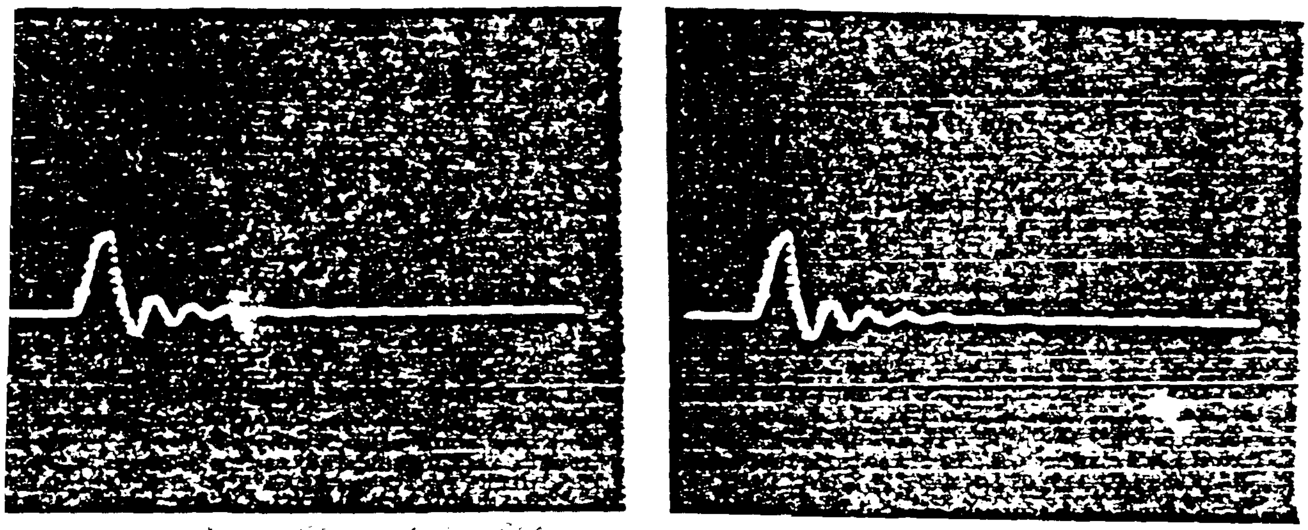
Tests Witnessed by: Scott McBride

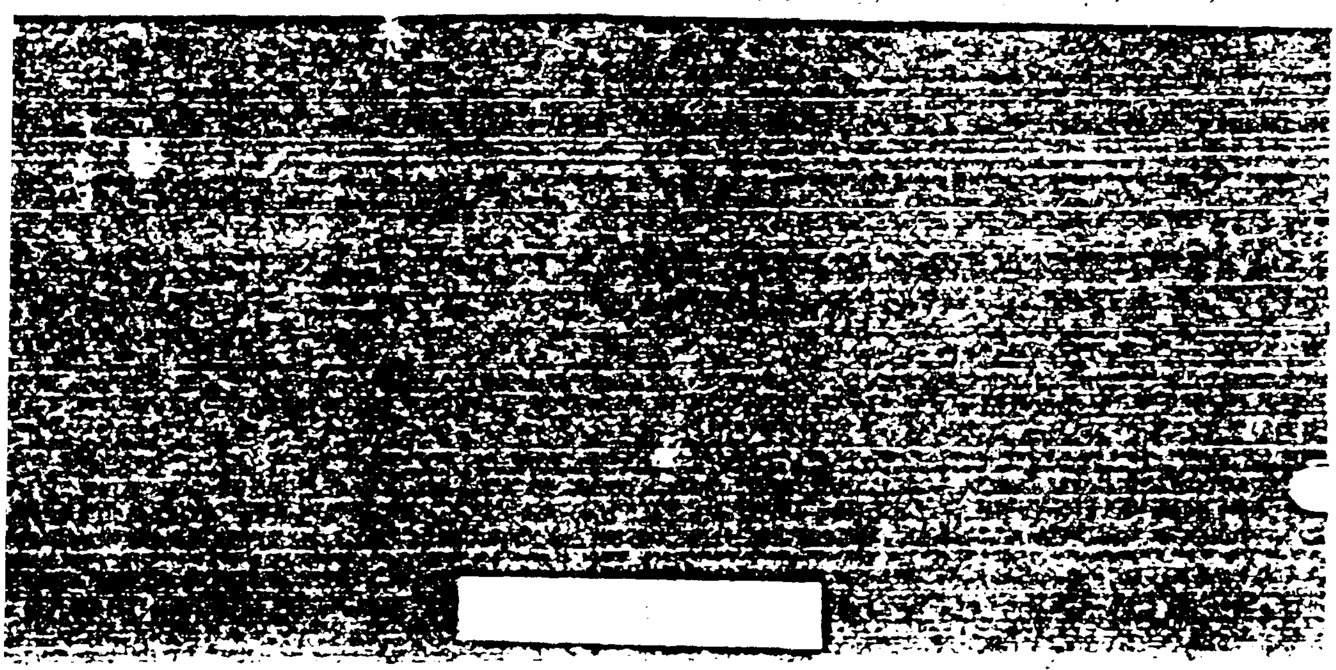
I hereby certify that this is a true report based on factory tests made in accordance with USA Standard Test Code for Distribution, Power and Regulating Transformers, C57.12 or latest revision thereof; and that each transformer withstood the above tests.

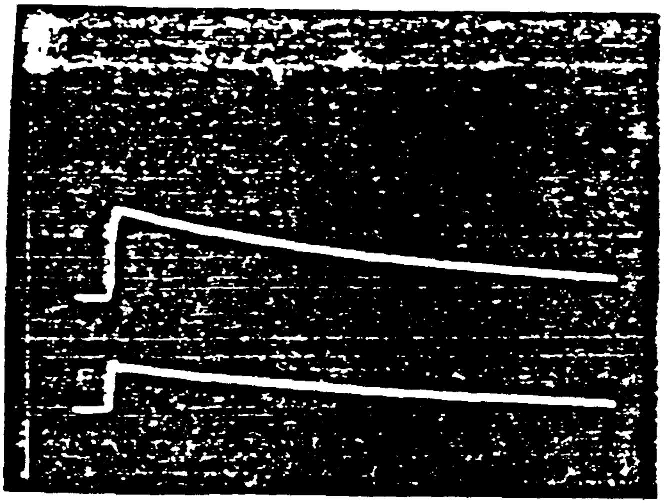
B-41

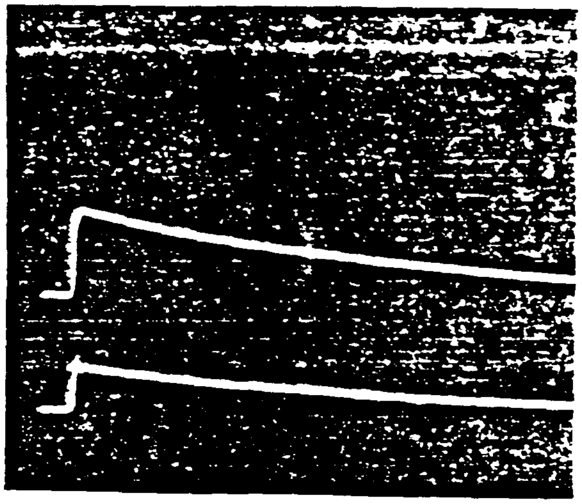
Signed: [signature] Date: 10/2/9[illegible] Approved: [signature]

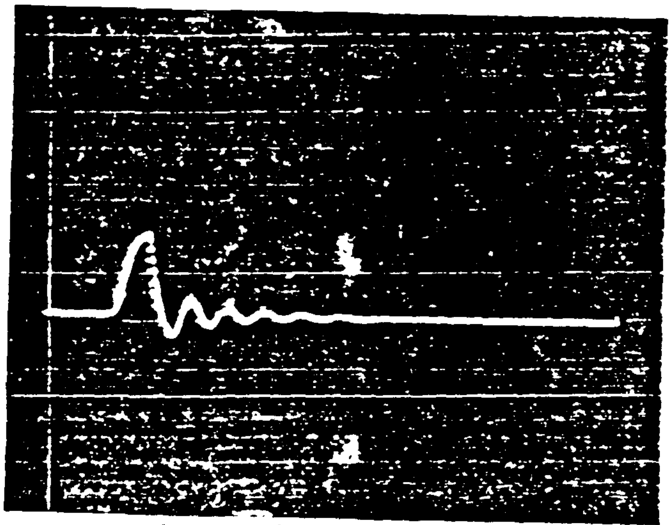


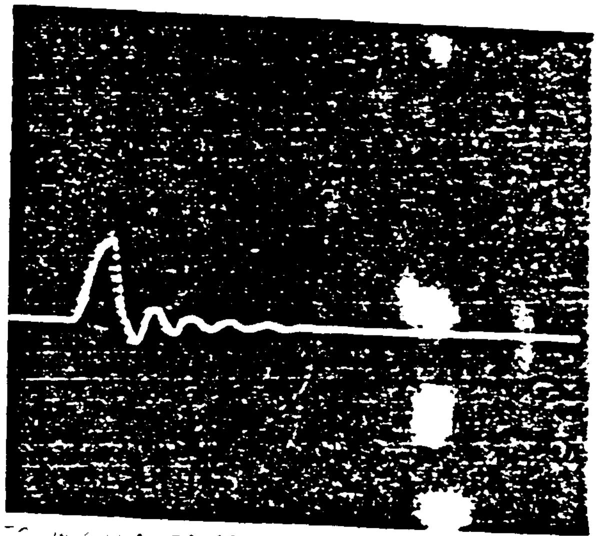


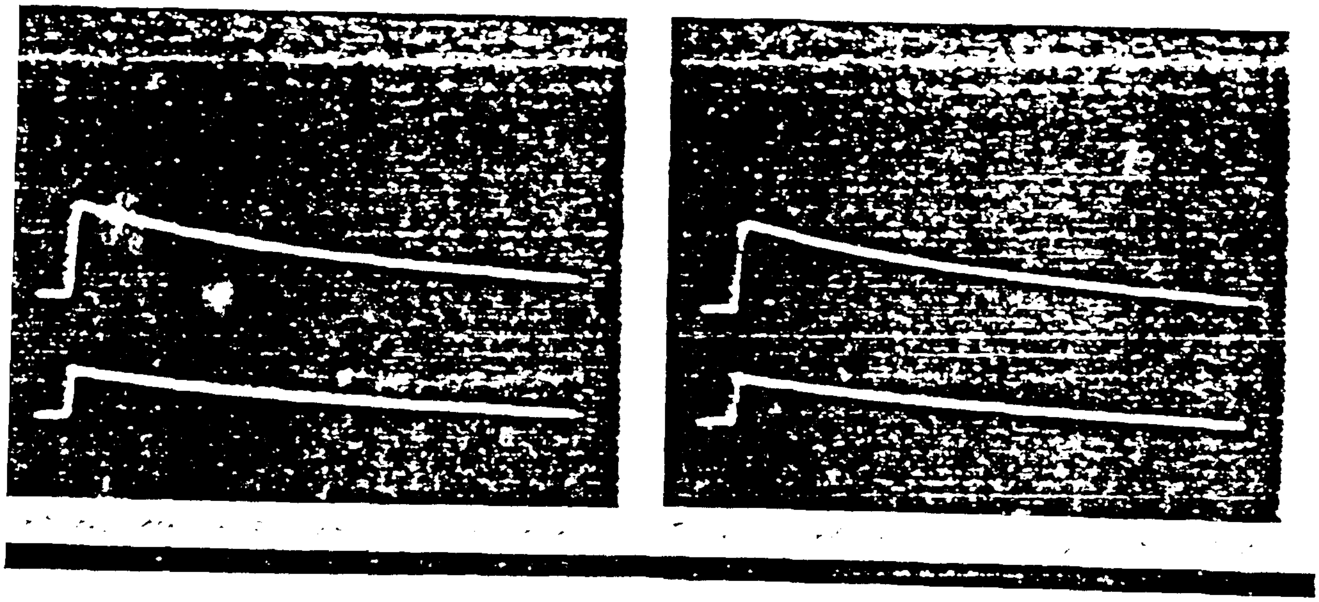


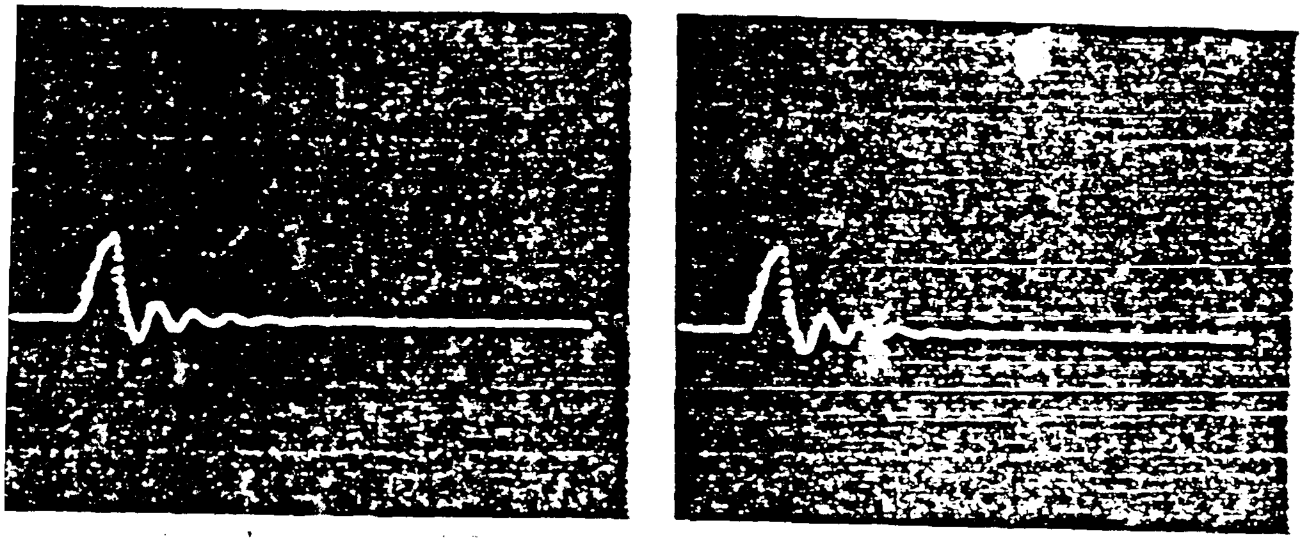


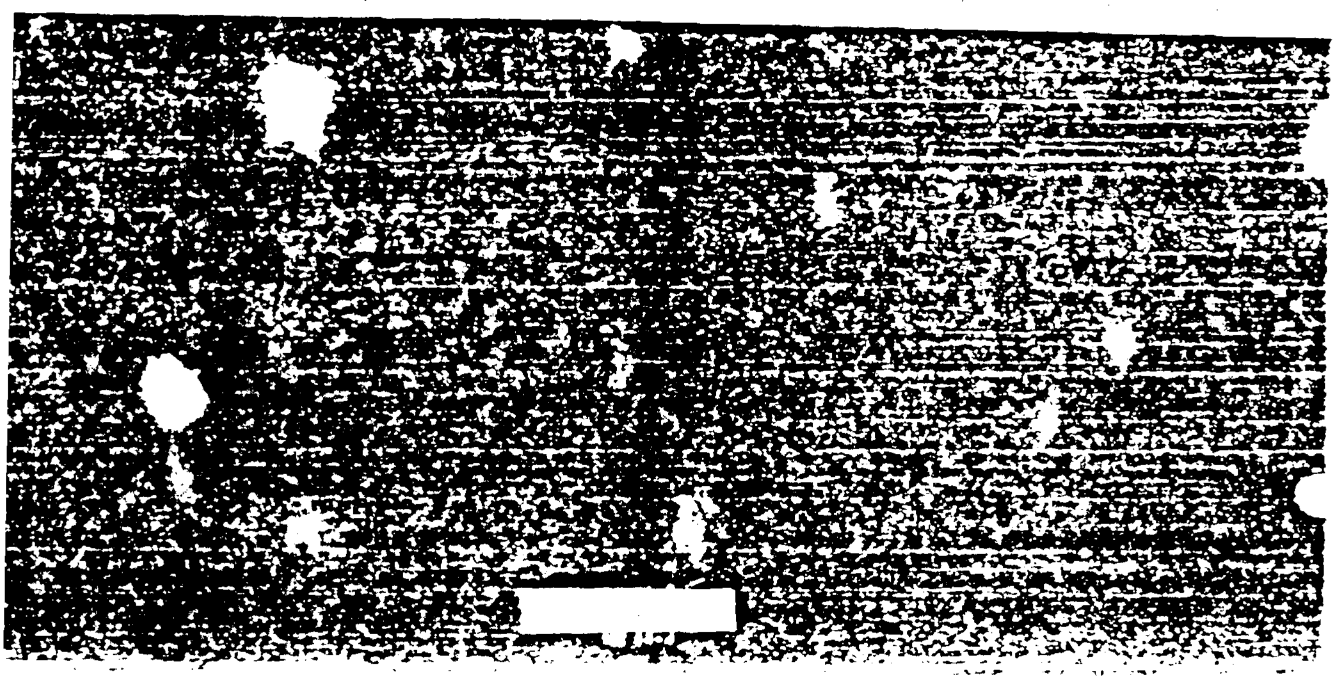












EB NATIONAL INDUSTRI

2520 58th Street
Hampton, Virginia 23661

Telephone
(804) 838-8080

Telex
82-3646

Telefax
(804) 838-8905

TRANSMITTAL LETTER

FOR

CERTIFIED TEST REPORT

RE: ABB SERVICE CO.
2382 E. ARTESIA BLVD.
LONG BEACH, CA 90805

DATE: OCT 16 1990

SHOP ORDER NO: 028990

ATTENTION: ROGER RATICAN

JOB NAME: TBA

CUSTOMER: ABB SERVICE CO.

P.O.NO: LS-01446-C

We are transmitting herewith four (4) copies of the Certified Test Report for your records.

If you have any questions, please do not hesitate to contact me.

Sincerely,

Libby Smith

Libby Smith
Customer Service Supervisor

EB NATIONAL INDUSTRI

CERTIFIED TEST REPORT

SHOP ORDER 02899-1 STYLE NO. 840750B056 TEST DATE 10-15-90

NOMINAL VOLTAGE: 12000 Delta / 480 Grd-Wye Three Phase 60 Hertz
KVA: 750/1000 CLASS: AA/FA AVG WDG RISE: 75 DEG.C
INSULATION RATED AT 185 DEGREE C BIL (kv): HV- 95 LV- 30

CUSTOMER: ABB SERVICE CO. PO# LS-01446-C
LONG BEACH, CA 90805

KVA	NO LOAD LOSSES 22 C (watts)	% Iex 22 C	TAP (volts)	LOAD LOSSES 95 C (watts)	% Z 95 C	TOTAL SERIES RESISTANCE @ 95 C PRIMARY (ohms)	SECONDARY (ohms)
750	2022	0.647	12000	5159	5.41	6.02399	0.002718

APPLIED VOLTAGE HV (kv)	LV (kv)	INDUCED VOLTAGE 400 Hz, 18 SEC. (volts)	NOMINAL RATIO	
34	4	960	A/B	43.271
			C/A	43.259
			B/C	43.260

ANSI STANDARD IMPULSE TEST PERFORMED AT 95 KV BIL.

AA MEASURED TEMPERATURE RISE (C): HV - 63.6 LV - 63.2

FA MEASURED TEMPERATURE RISE (C): HV - 56.9 LV - 50.2

IMPEDANCE AND LOAD LOSSES AT TAPS:
(1-2) = 5.33% AND 5020 WATTS, (5-6) = 5.52% AND 5340 WATTS.
PARTIAL DISCHARGE TEST PERFORMED, SEE ATTACHED FOR TEST RESULTS.
POWER FACTOR TEST PERFORMED AT 2.5 KV:
H-G = .805, L-G = .495 AND H-L = .182

CERTIFICATION:

TEST TECHNICIAN ______________ ENGINEER ______________

NATIONAL INDUSTRI TRANSFORMERS, INC.
HAMPTON, VA. 23661

PARTIAL DISCHARGE TEST DATA

SHOP ORDER C2899-1
STYLE NO. 840750B056
KVA 750
TEST DATE OCTOBER 15, 1990

TOP	% VOLTAGE	COIL 1	COIL 2	COIL 3
INCEPTION	150	5 pc	3 pc	5 pc
EXTINCTION	110	0 pc	0 pc	0 pc

BOTTOM	% VOLTAGE	COIL 1	COIL 2	COIL 3
INCEPTION	150	5 pc	3 pc	3 pc
EXTINCTION	110	5 pc	3 pc	3 pc

NATIONAL INDUSTRI

TRANSFORMERS, INC.

Hampton, VA 23661
804 838-8080
Telex 82-3646

ISSUED 9/7/79
REVISED 12/8/83
SECTION B-7

TRANSFORMER IMPULSE TEST REPORT

Purchaser: FBP [illegible]

Date of Test: 10/16/90 Purchaser's Order No. LS-01446-C Mfr's. Ref. [illegible]

Type [illegible] Phase 3 Hertz 60 Insulating Fluid

H Winding 750 KVA X Winding 750 KVA Y Winding KVA

12000 DELTA Volts 480 GRDY/277 Volts Volts

95K BIL 30K BIL BIL

Serial No.	Terminal Surged	Test*	Crest Voltage KV	Wave Shape or Rate of Rise	Time to Flashover	Oscillogram Number	Sweep Time or Timing Wave Freq. μ Sec.	Connection of Other Winding Terminals
195-1	H-1	RFWV	47.5	1.25/50μs		1	10	[illegible]
		RFWC				1C	10	Current [illegible]
		CWV	95		1.90μs	2	2	
		CWV	95		1.75μs	3	2	
		FWV	95	1.25/50μs		4	10	
		FWC				4C	10	
	H-2	RFWV	47.5	1.25/50μs		5	10	
		RFWC				5C	10	
		CWV	95		1.90μs	6	2	
		CWV	95		1.80μs	7	2	
		FWV	95	1.25/50μs		8	10	
		FWC				8C	10	
	H-3	RFWV	47.5	1.25/50μs		9	10	
		RFWC				9C	10	
		CWV	95		2.0μs	10	2	
		CWV	95		1.85μs	11	2	
		FWV	95	1.25/50μs		12	10	
		FWC				12C	10	

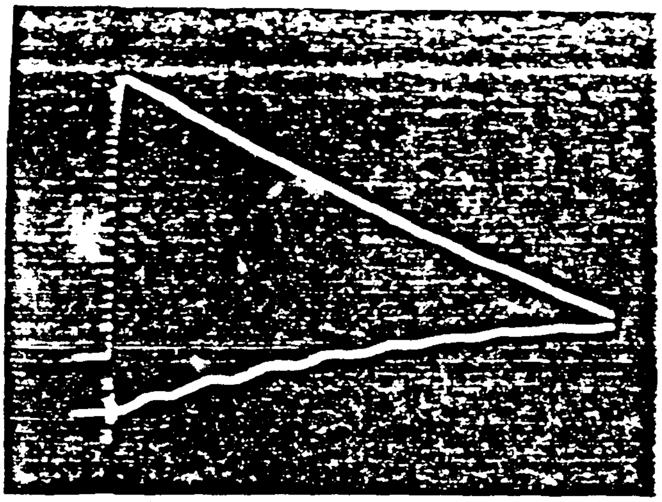
* RFWV Reduced Full-Wave Voltage. RFWC Reduced Full-Wave Current. FWV Full-Wave Voltage. FWC Full-Wave Current. CWV Chopped-Wave Voltage. FCWV Front of Wave Voltage.

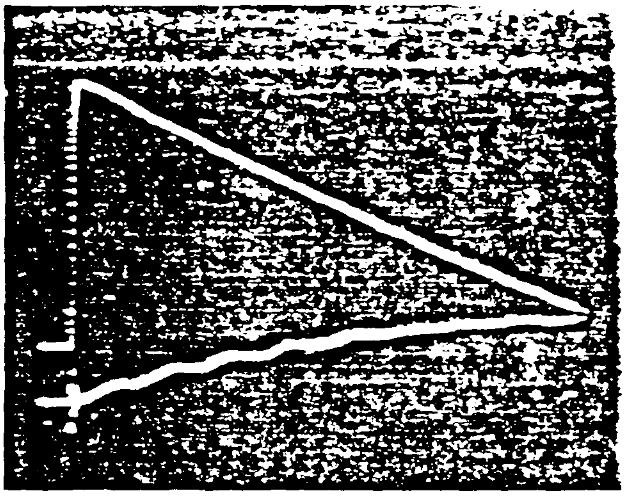
GRD Terminals grounded. ARR Terminals connected to arresters. RES Terminals connected to ground through linear resistance.

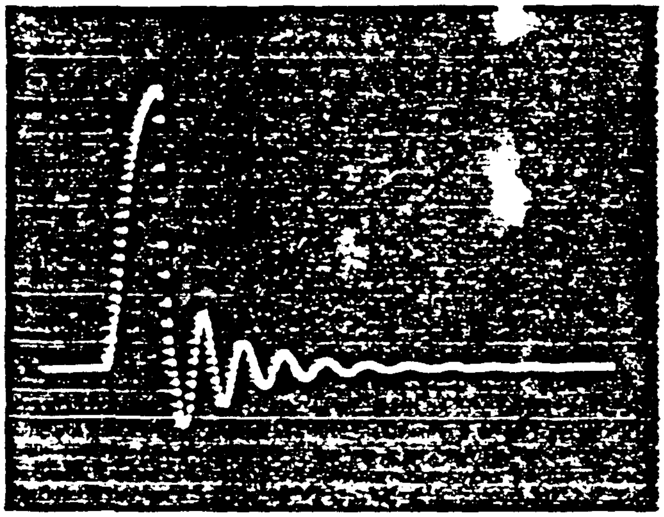
Tests Witnessed by

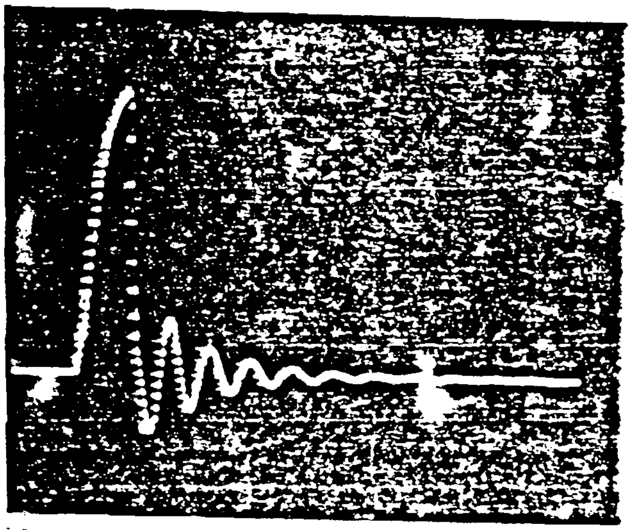
I hereby certify that this is a true report based on factory tests made in accordance with USA Standard Test Code for Distribution, Power and Regulating Transformers, C57.12 or latest revision thereof; and that each transformer withstood the above tests.

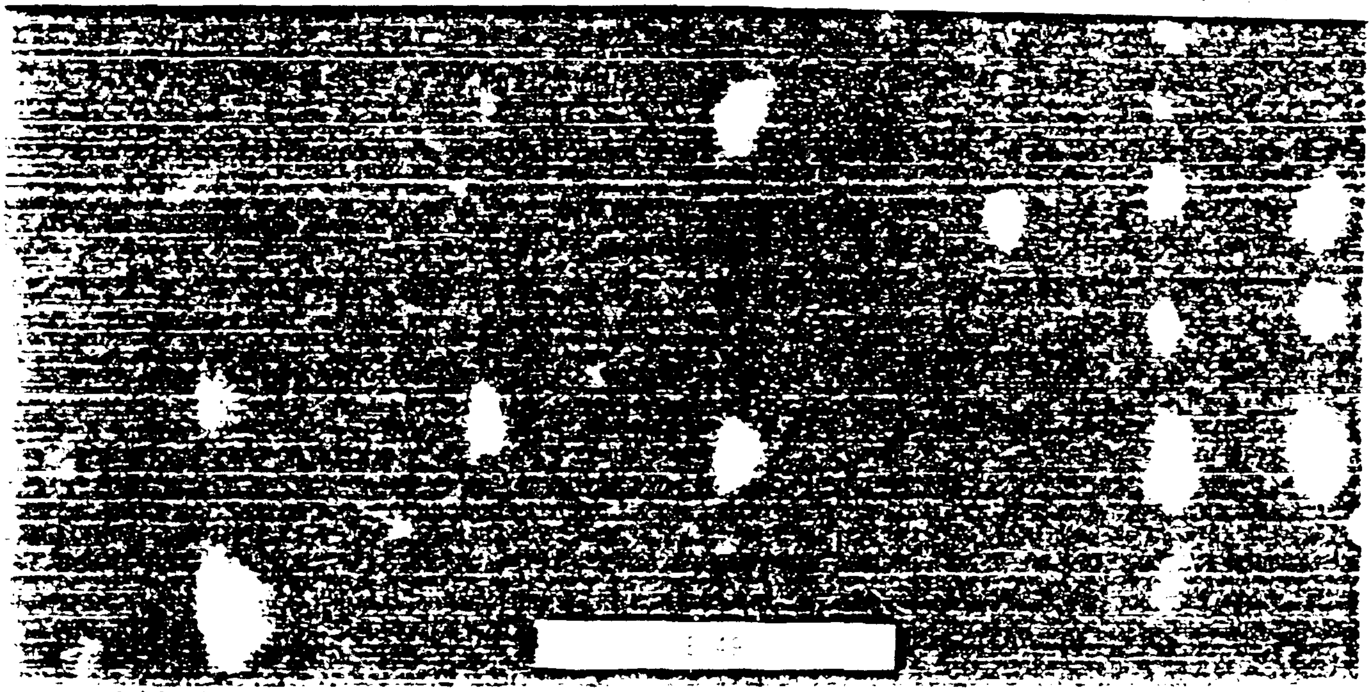
Signed [signature] Date 10/16/90 Approved [signature]

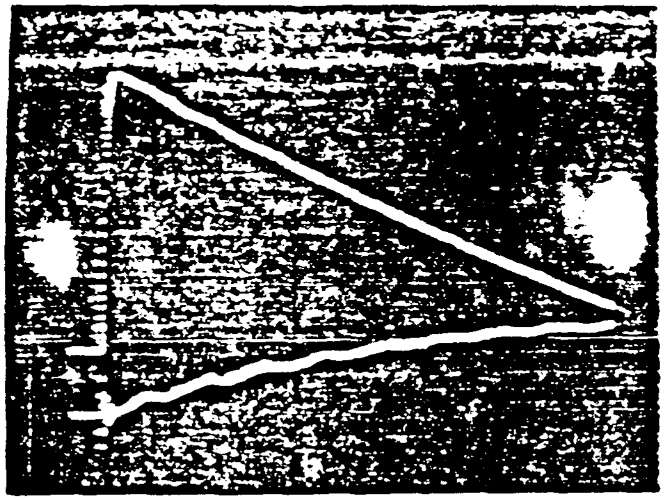


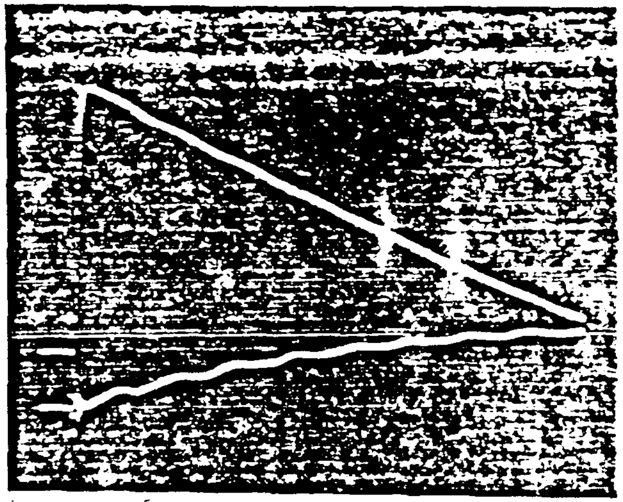


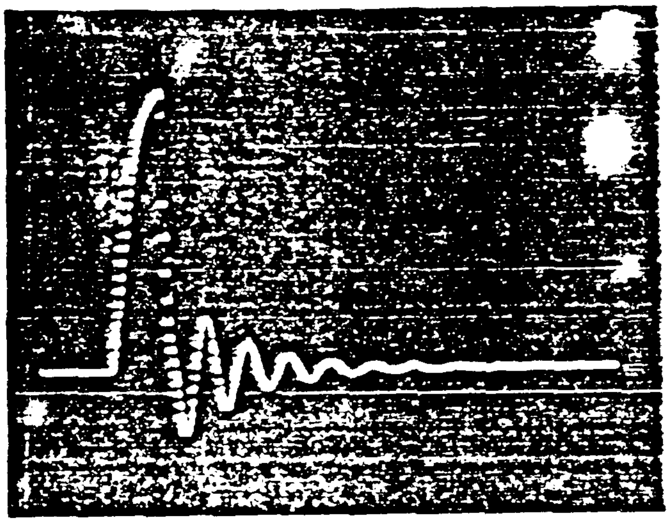


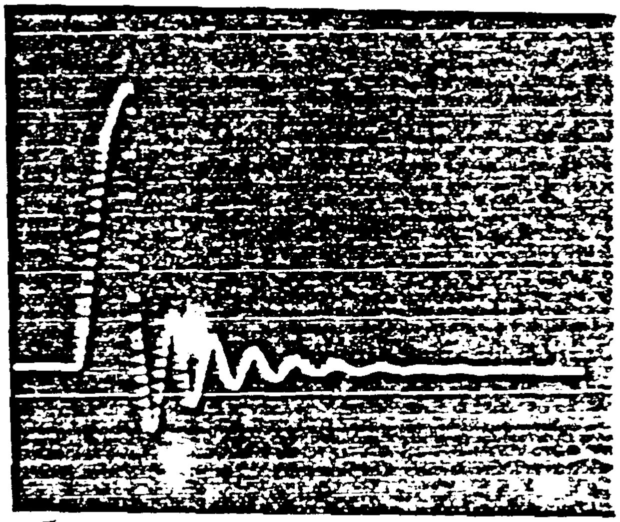


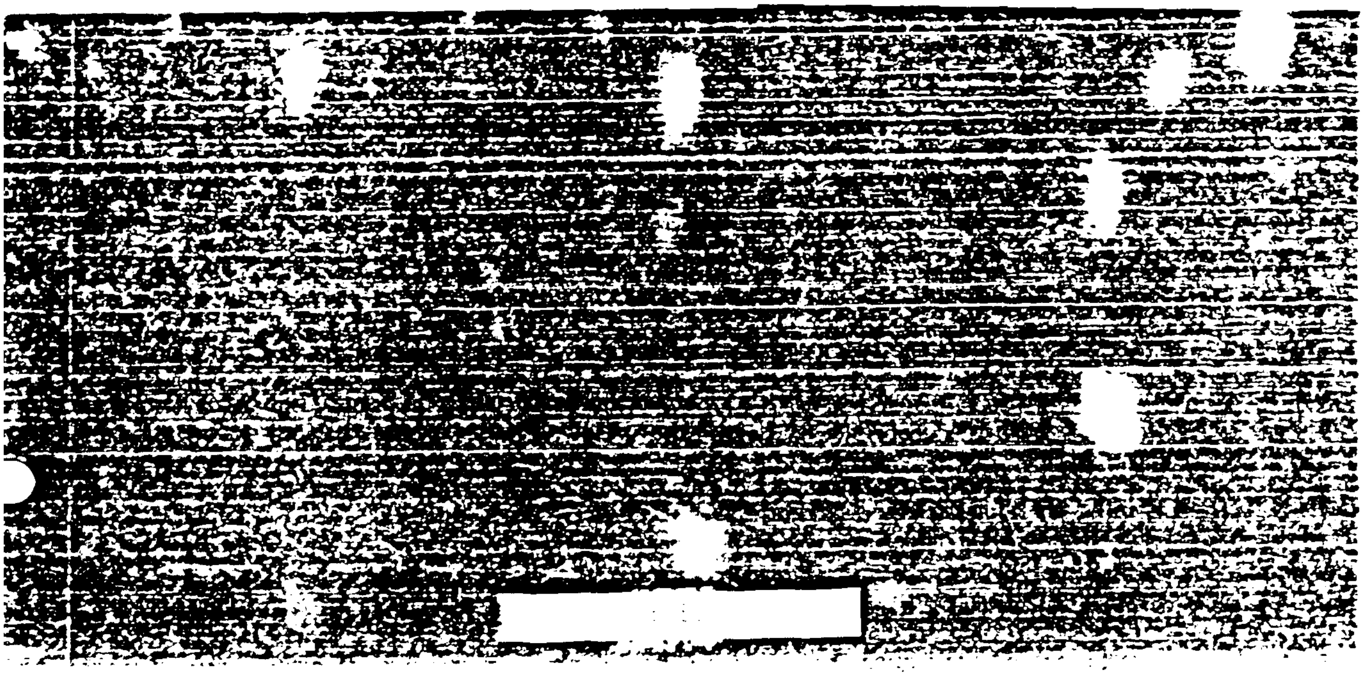


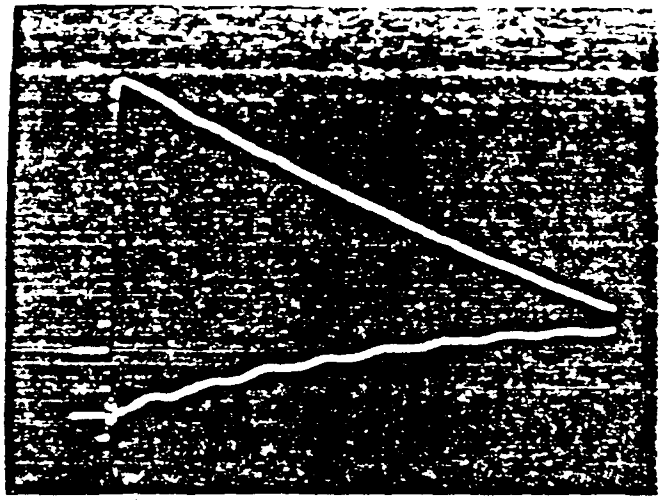


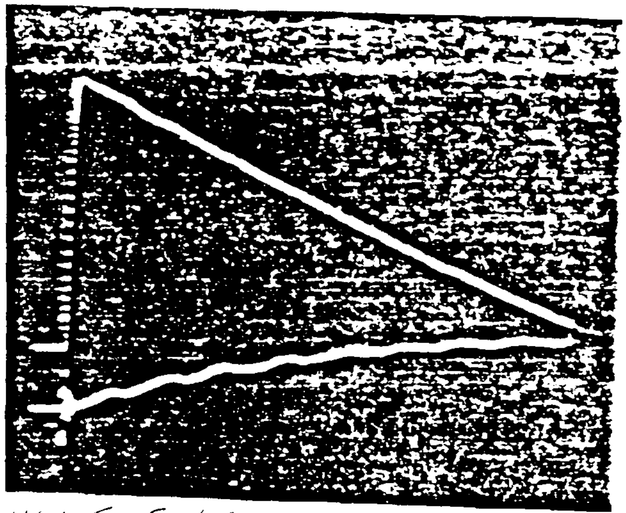


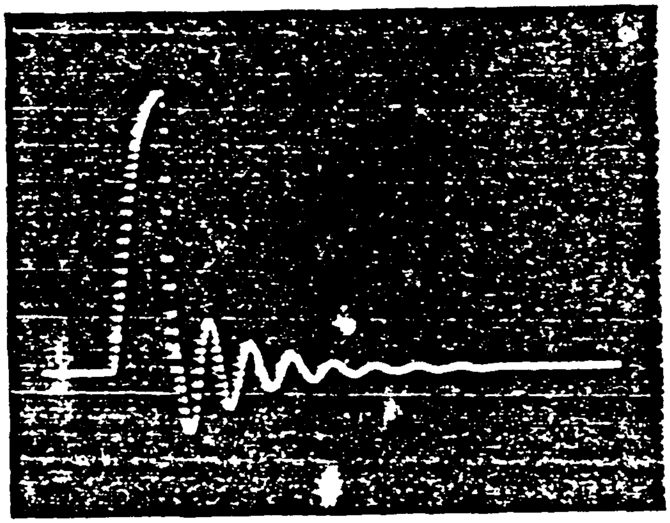


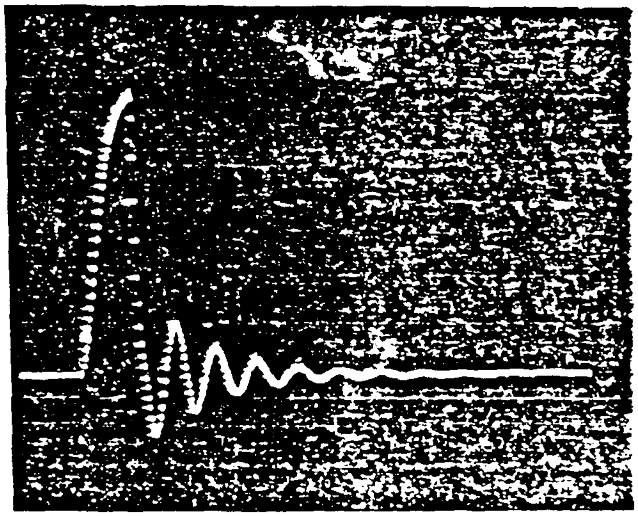












EB NATIONAL INDUSTRI

2520 58th Street
Hampton, Virginia 23661

Telephone
(804) 838-8080

Telex
82-3646

Telefax
(804) 838-8905

TRANSMITTAL LETTER

FOR

CERTIFIED TEST REPORT

RE: ABB SERVICE CO.
2362 E. ARTESIA BLVD.
LONG BEACH, CA 90805

DATE: OCT 16 1990

SHOP ORDER NO: 029000

ATTENTION: ROGER RATICAN

JOB NAME: TBA

CUSTOMER: ABB SERVICE CO.

P.O.NO: LS-01446-C

We are transmitting herewith four (4) copies of the Certified Test Report for your records.

If you have any questions, please do not hesitate to contact me.

Sincerely,

Libby Smith

Libby Smith
Customer Service Supervisor

EB NATIONAL INDUSTRI

CERTIFIED TEST REPORT

SHOP ORDER 02900-1 STYLE NO. 810500B001 TEST DATE 10-10-90

NOMINAL VOLTAGE: 480 Delta / 208 Grd-Wye Three Phase 60 Hertz
KVA: 500/667 CLASS: AA/FFA AVG WDG RISE: 75 DEG C.
INSULATION RATED AT 185 DEGREE C BIL (kv): HV- 30 LV- 30

CUSTOMER: ABB SERVICE CO. PO# LS-01446-C
LONGBEACH, CA 90805

KVA	NO LOAD LOSSES 25 C (watts)	% Iex 25 C	TAP (volts)	LOAD LOSSES 95 C (watts)	% Z 95 C	TOTAL SERIES RESISTANCE @ 95 C PRIMARY (ohms)	SECONDARY (ohms)
500	1483	0.953	480	6204	6.22	0.02384	0.001183

APPLIED VOLTAGE HV (kv)	LV (kv)	INDUCED VOLTAGE 400 Hz, 18 SEC. (volts)	NOMINAL RATIO	
12	4	416	A/B	3.994
			C/A	3.991
			B/C	3.991

ANSI STANDARD IMPULSE TEST PERFORMED AT 30 KV BIL.

AA MEASURED TEMPERATURE RISE (C): HV - 53.1 LV - 54.5

PARTIAL DISCHARGE TEST PERFORMED, SEE ATTACHED FOR TEST RESULTS.
POWER FACTOR TEST PERFORMED AT 2.5 KV:
H-L = .296, H-G = .605 & L-G = .338
IMPEDANCE AND LOAD LOSSES AT TAPS:
(1-2) = 6.11% AND 6442 WATTS, (5-6) = 6.32% AND 6122 WATTS

CERTIFICATION:

TEST TECHNICIAN ______ ENGINEER Michael E Hal[illegible]

NATIONAL INDUSTRI TRANSFORMERS, INC.
HAMPTON, VA. 23661

PARTIAL DISCHARGE TEST DATA

SHOP ORDER 02900-1
STYLE NO. 810500B001
KVA 500
TEST DATE OCTOBER 10, 1990

TOP	% VOLTAGE	COIL 1	COIL 2	COIL 3
INCEPTION	150	30 pc	35 pc	30 pc

BOTTOM	% VOLTAGE	COIL 1	COIL 2	COIL 3
INCEPTION	150	32 pc	35 pc	32 pc

NATIONAL INDUSTRI
TRANSFORMERS, INC.
Hampton, VA 23661
(804) 838-8080
Telex 82-3646

TRANSFORMER IMPULSE TEST REPORT

Purchaser ARB SERVICE CO.

Date of Test 10/10/90 Purchaser's Order No. LS-01446-C Mfr's. Ref. 81-0500-B001

Type CAST-COAST Phase 3 Hertz 60 Insulating Fluid ______

H Winding 500 KVA X Winding 500 KVA Y Winding ______ KVA

480 DELTA Volts 208 Grdy/120 Volts ______ Volts

30 K BIL 30 K BIL ______ BIL

Serial No.	Terminal Surged	Test*	Crest Voltage KV	Wave Shape of Rate of Rise	Time to Flashover	Oscillogram Number	Sweep Time or Timing Wave Freq. μ Sec.	Con...
C2900-1	H-1	RFWV	15	1.50/47μs		1	10	Grou...
		RFWC				1c	10	Curr...
		CWV	30		1.40μs	2	2	
		CWV	30		1.60μs	3		
		FWV	30	1.5/47μs		4	10	
		FWC				4c	10	
	H-2	RFWV	15	1.50/47μs		5	10	
		RFWC				5c	10	
		CWV	30		1.70μs	6	2	
		CWV	30		1.70μs	7	2	
		FWV	30	1.50/47μs		8	10	
		FWC				8c	10	
	H-3	RFWV	15	1.50/47μs		9	10	
		RFWC				9c	10	
		CWV	30		1.30μs	10	2	
		CWV	30		1.35μs	11	2	
		FWV	30	1.50/47μs		12	10	
		FWC				12c	10	

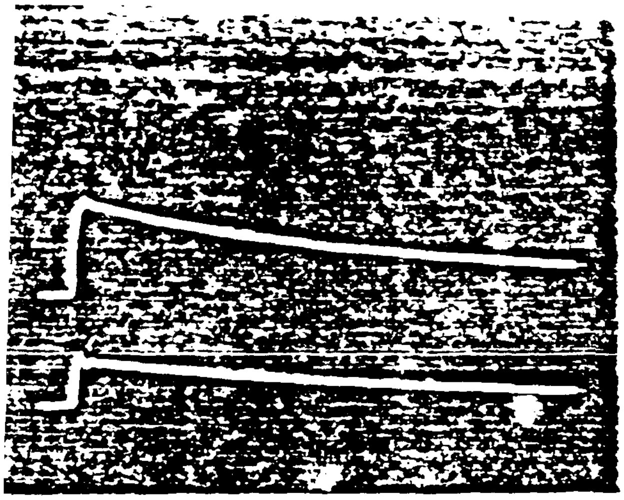
* RFWV Reduced Full-Wave Voltage, RFWC Reduced Full-Wave Current, FWV Full-Wave Voltage, FWC Full-Wav Current, CWV Chopped-Wave Voltage, FOWV Front of Wave Voltage.

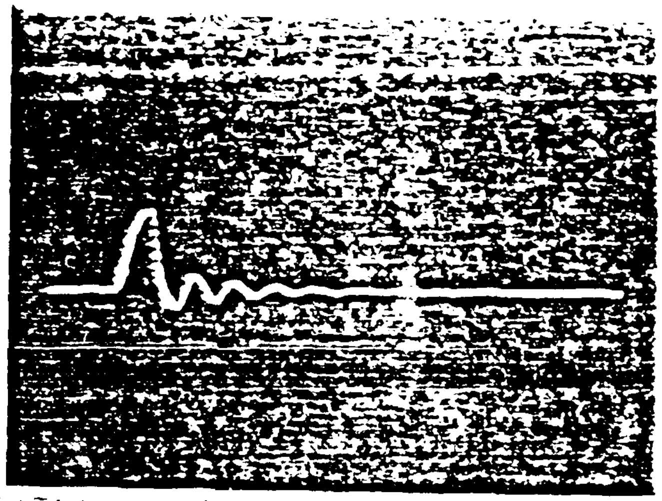
GRD Terminals grounded. ARR Terminals connected to arresters. RES Terminals connected to gr through linear resistance.

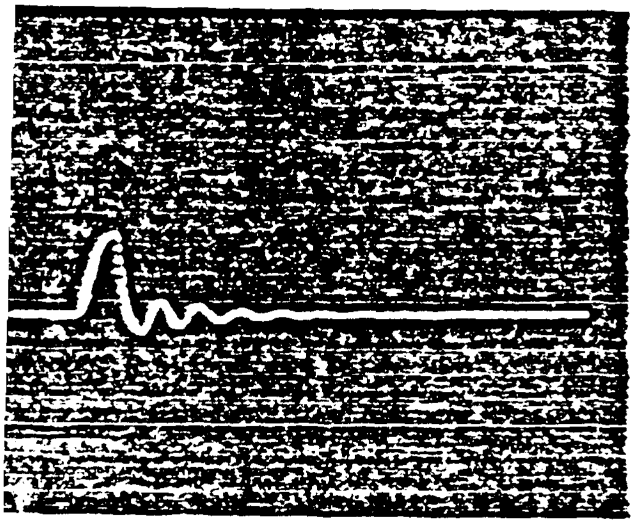
Tests Witnessed by Scott McBride (EE&E)

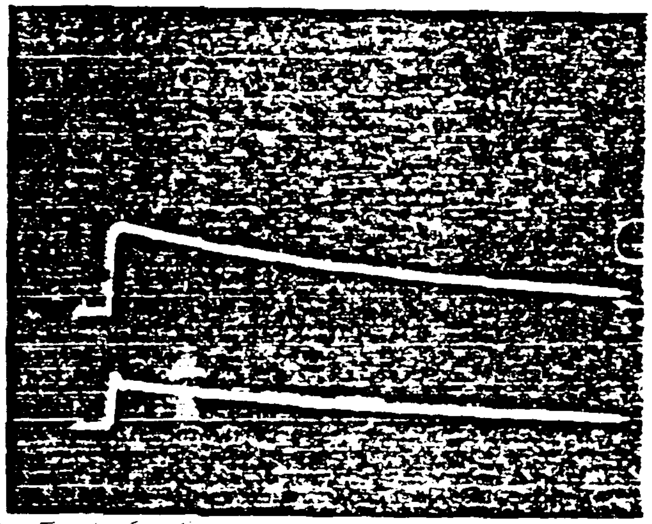
I hereby certify that this is a true report based on factory tests made in accordance with USA Standard Test Code fo Distribution, Power and Regulating Transformers, C57.12 or latest revision thereof; and that each transformer withstoo the above tests.

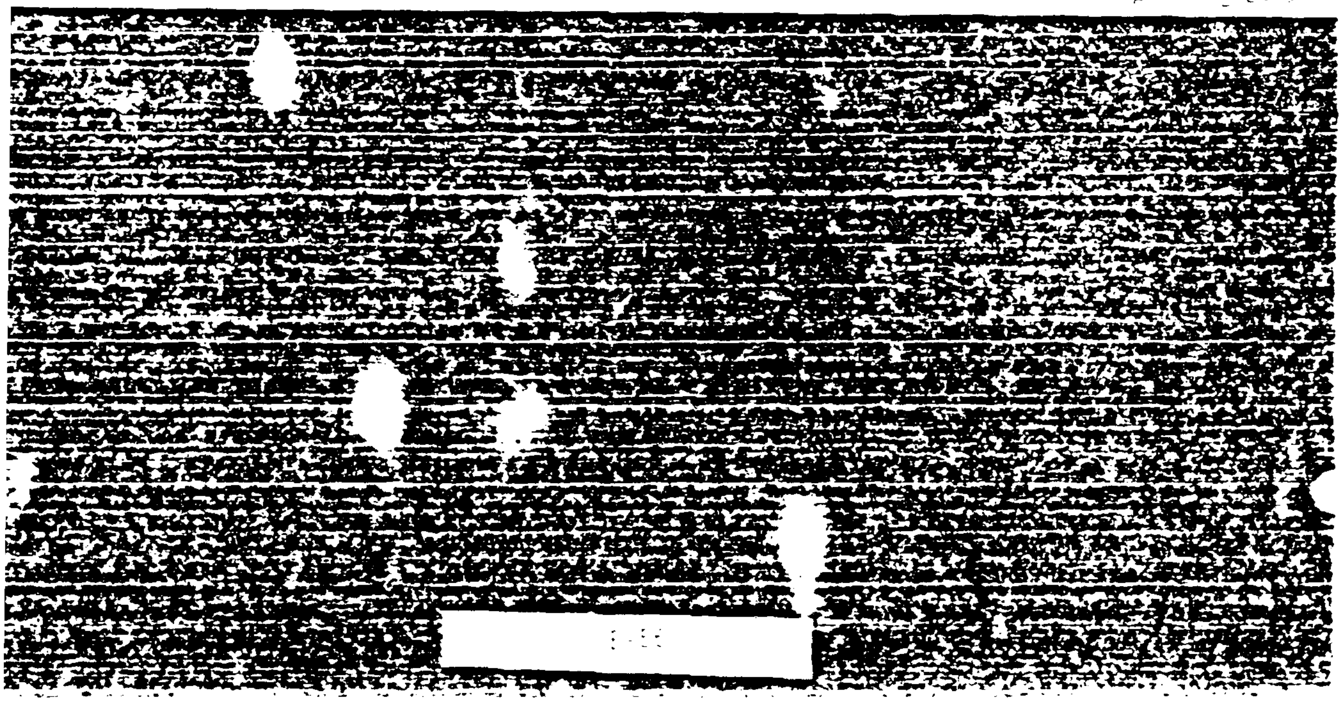
Signed [illegible] Date 10/10/90 Approved M E Hu[illegible]

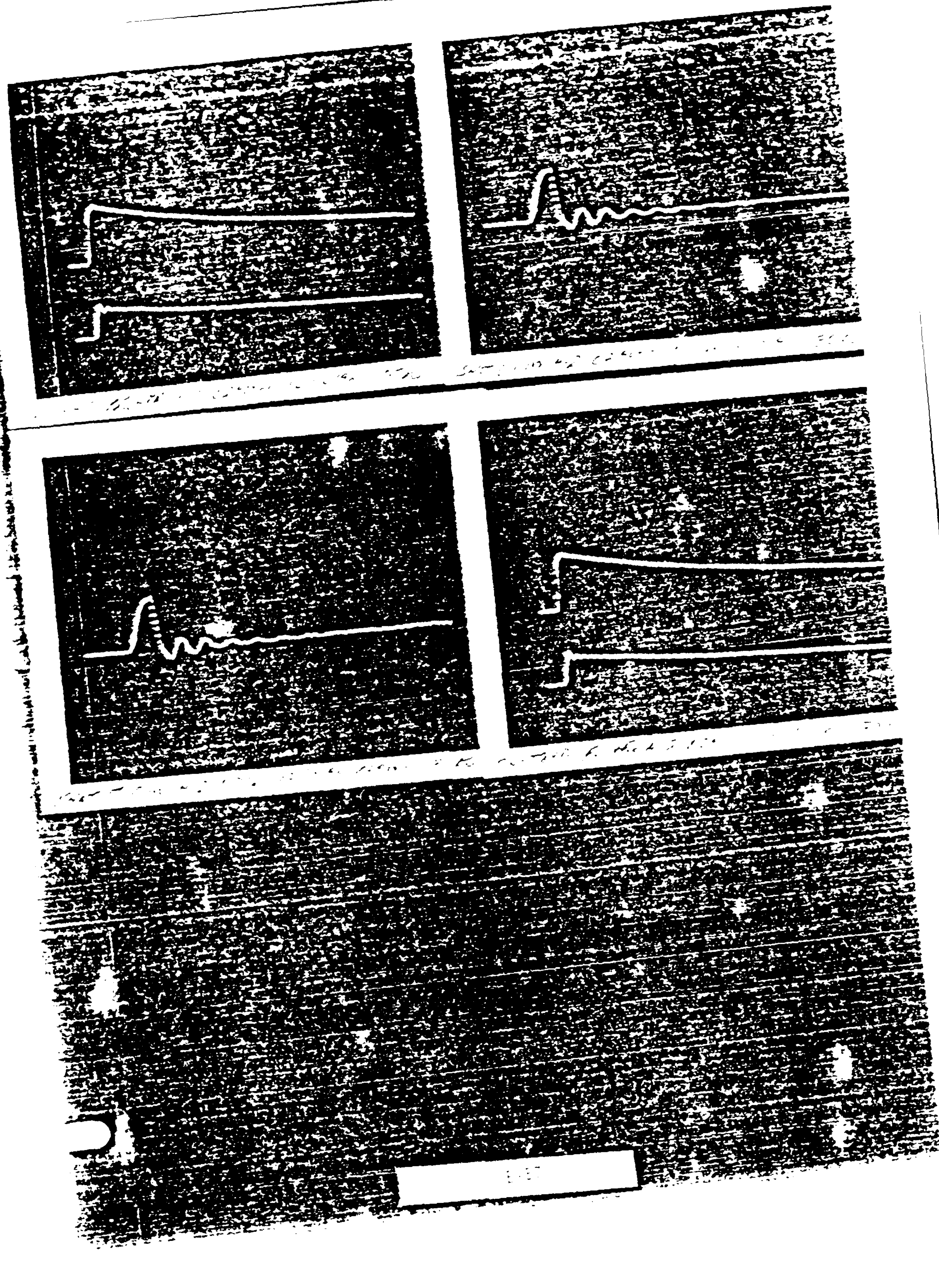


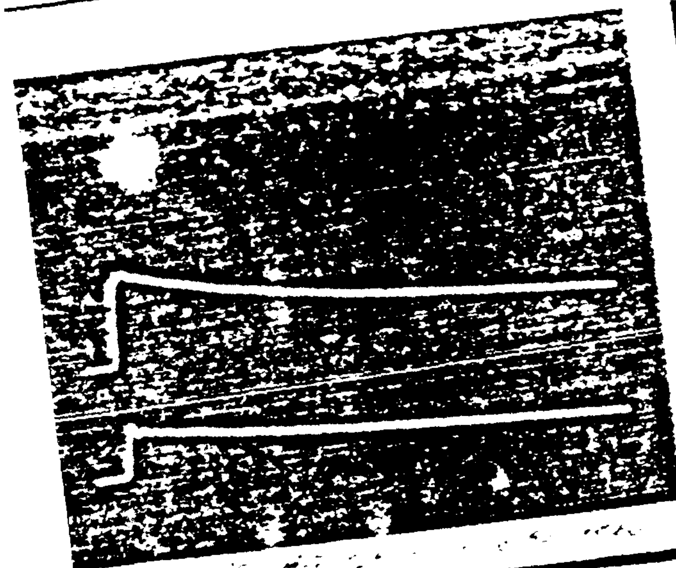


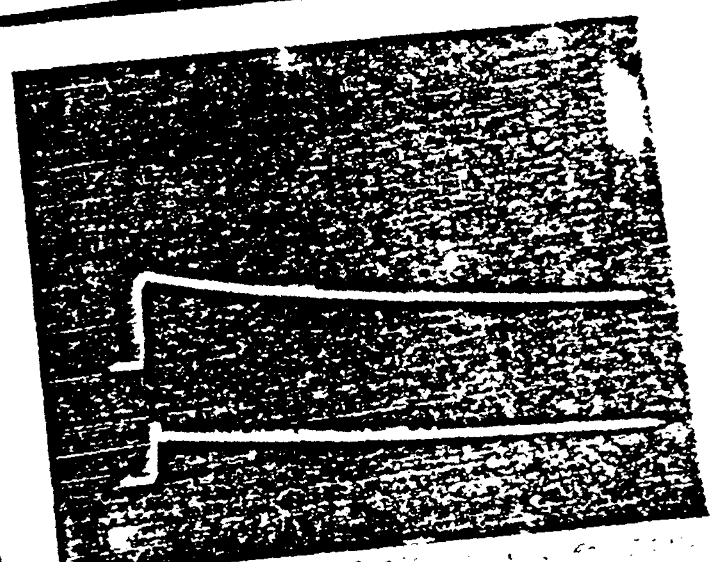
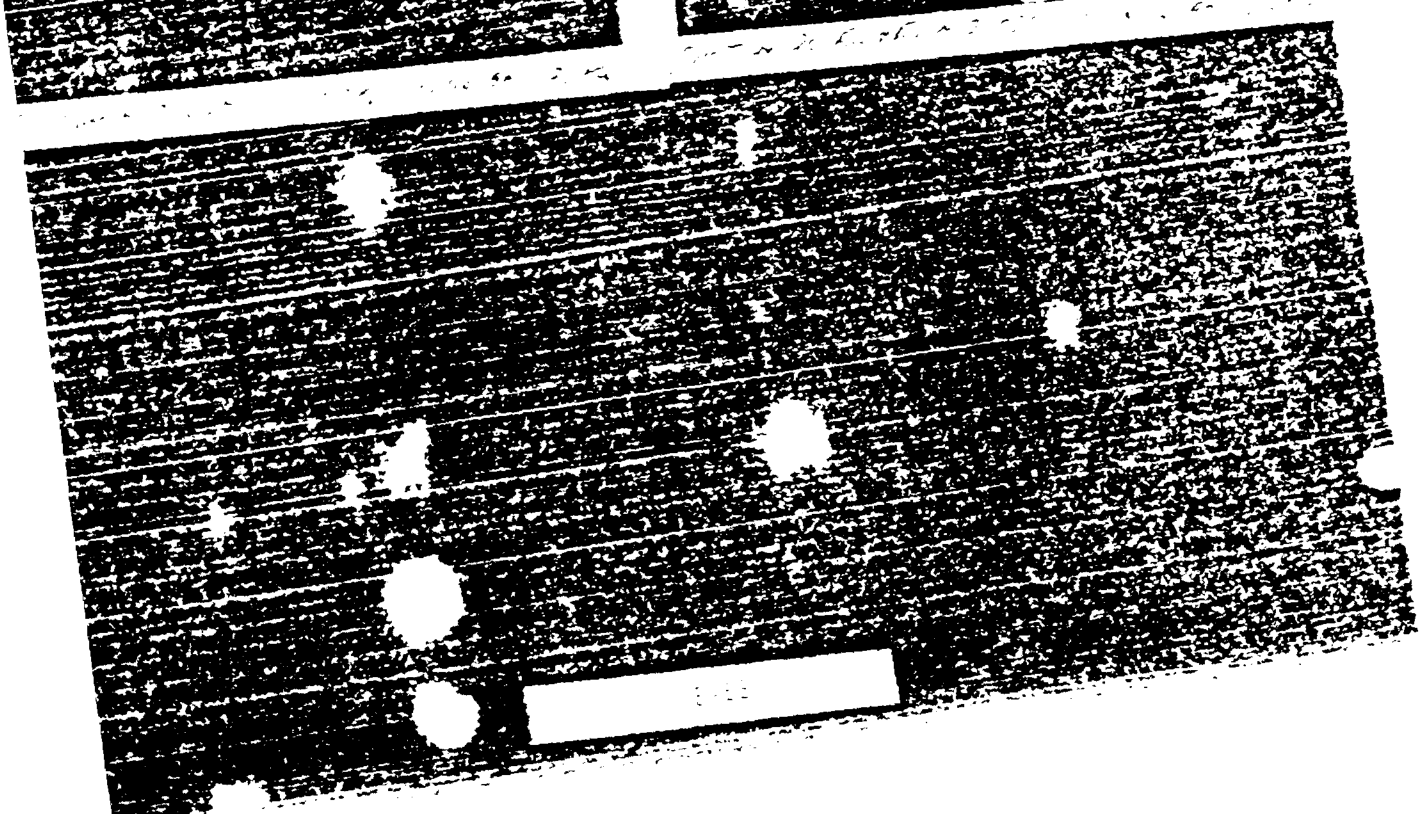










EB NATIONAL INDUSTRI

2520 58th Street
Hampton, Virginia 23661

Telephone
(804) 838-8080

Telex
82-3646

Telefax
(804) 838-8905

TRANSMITTAL LETTER

FOR

CERTIFIED TEST REPORT

RE: ABB SERVICE CO.
2382 E. ARTESIA BLVD.
LONG BEACH, CA 90805

DATE: OCT 16 1990

SHOP ORDER NO: 029010

ATTENTION: ROGER RATICAN

JOB NAME: TEA

CUSTOMER: ABB SERVICE CO.

P.O.NO: LS-01446-C

We are transmitting herewith four (4) copies of the Certified Test Report for your records.

If you have any questions, please do not hesitate to contact me.

Sincerely,

Libby Smith

Libby Smith
Customer Service Supervisor

EB NATIONAL INDUSTRI

CERTIFIED TEST REPORT

SHOP ORDER 02901-1 STYLE NO. 841500B109 TEST DATE 10-08-90

NOMINAL VOLTAGE: 12000 Delta / 480 Grd-Wye Three Phase 60 Hertz
KVA: 1500/2000 CLASS: AA/FFA AVG WDG RISE: 75 DEG C.
INSULATION RATED AT 185 DEGREE C BIL (kv): HV- 95 LV- 30

CUSTOMER: ABB SERVICE CO. PO# LS-01446-C
LONG BEACH, CA 90805

KVA	NO LOAD LOSSES 23 C (watts)	% Iex 23 C	TAP (volts)	LOAD LOSSES 95 C (watts)	% Z 95 C	TOTAL SERIES RESISTANCE @ 95 C PRIMARY (ohms)	SECONDARY (ohms)
1500	3689	0.647	12000	9441	5.60	2.43206	0.001307

APPLIED VOLTAGE HV (kv)	LV (kv)	INDUCED VOLTAGE 400 Hz, 18 SEC. (volts)	NOMINAL RATIO	
34	4	960	A/B	43.285
			C/A	43.255
			B/C	43.265

ANSI STANDARD IMPULSE TEST PERFORMED AT 95 KV BIL.

AA MEASURED TEMPERATURE RISE (C): HV - 67.4 LV - 64.8

IMPEDANCE AND LOAD LOSSES AT TAPS:
(1-2) = 5.51% AND 9129 WATTS, (5-6) = 5.77% AND 9794 WATTS.
PARTIAL DISCHARGE TEST PERFORMED, SEE ATTACHED FOR TEST RESULTS.
POWER FACTOR TEST PERFORMED AT 2.5 KV:
H-G = .224, L-G = .501 AND H-L = .196

CERTIFICATION:

TEST TECHNICIAN [signature] ENGINEER [signature]

NATIONAL INDUSTRI TRANSFORMERS, INC.
HAMPTON, VA. 23661

PARTIAL DISCHARGE TEST DATA

SHOP ORDER 02901-1
STYLE NO. 841500B109
KVA 1500
TEST DATE OCTOBER 8, 1990

TOP	% VOLTAGE	COIL 1	COIL 2	COIL 3
INCEPTION	150	30 pc	5 pc	20 pc
EXTINCTION	110	0 pc	0 pc	0 pc

BOTTOM	% VOLTAGE	COIL 1	COIL 2	COIL 3
INCEPTION	150	30 pc	3 pc	25 pc
EXTINCTION	110	0 pc	0 pc	0 pc

NATIONAL INDUSTRI
TRANSFORMERS, INC.

Hampton, VA 23661
804 838-8080
Telex 82-3646

ISSUED 9-7-79
REVISED 12-9-82
SECTION B-7

TRANSFORMER IMPUSE TEST REPORT

Purchaser: ABB Service Co.

Date of Test: 10/8/90 Purchaser's Order No.: LS-04448-C Mfr's. Ref.: P4-1500-1509

Type: CAR-LIN? Phase: 3 Hertz: 60 Insulating Fluid: ____

H Winding ____ KVA X Winding 1500 KVA Y Winding ____ KVA

12000 DELTA Volts 480 GRDY/277 Volts ____ Volts

95KV BIL 30KV BIL ____ BIL

Serial No.	Terminal Surged	Test*	Crest Voltage KV	Wave Shape or Rate of Rise	Time to Flashover	Oscillogram Number	Sweep Time or Timing Wave Freq. N Sec.	Conn. of Unimp. Term.
101-1	H-1	RFWV	47.5	1.25/43μs		1	10	Ground Term.
		RFWC				1c	10	Shunt
		CWV	95		1.90μs	2	2	
		CWV	95		1.85μs	3	2	
		FWV	95	1.25/43μs		4	10	
		FWC				4c	10	
	H-2	RFWV	47.5	1.25/43μs		5	10	
		RFWC				5c	10	
		CWV	95		1.70μs	6	2	
		CWV	95		1.90μs	7	2	
		FWV	95	1.25/43μs		8	10	
		FWC	—	—	—	8c	10	
	H-3	RFWV	47.5	1.25/43μs		9	10	
		RFWC	--			9c	10	
		CWV	95		1.85μs	10	2	
		CWV	95		1.82μs	11	2	
		FWV	95	1.25/43μs		12	10	
		FWC				12c	10	

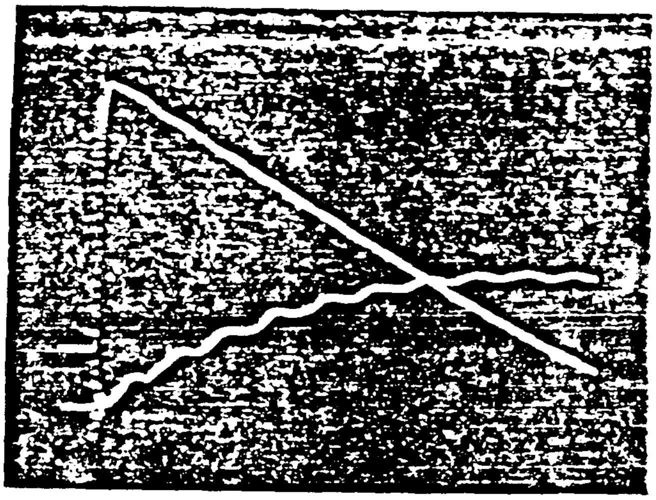
* RFWV Reduced Full-Wave Voltage, RFWC Reduced Full-Wave Current, FWV Full-Wave Voltage, FWC Full-Wave Current, CWV Chopped-Wave Voltage, FCWV Front of Wave Voltage.

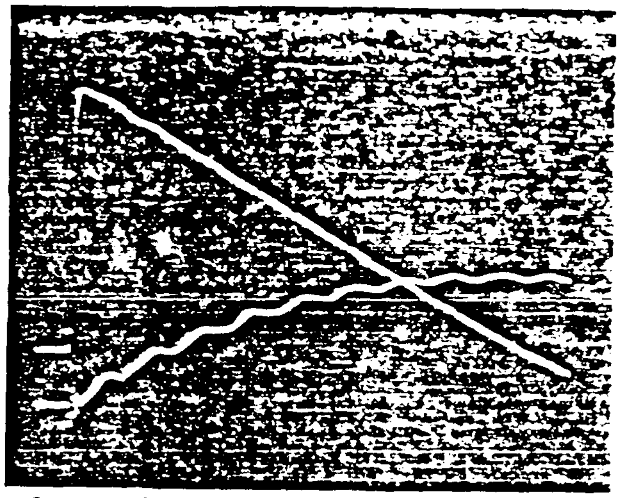
GRD Terminals grounded. ARR Terminals connected to arresters. RES Terminals connected to ground through linear resistance.

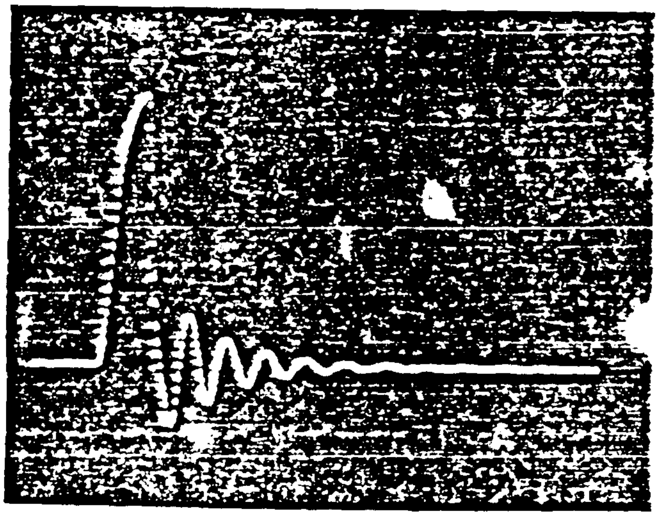
Tests Witnessed by: Scott McBride

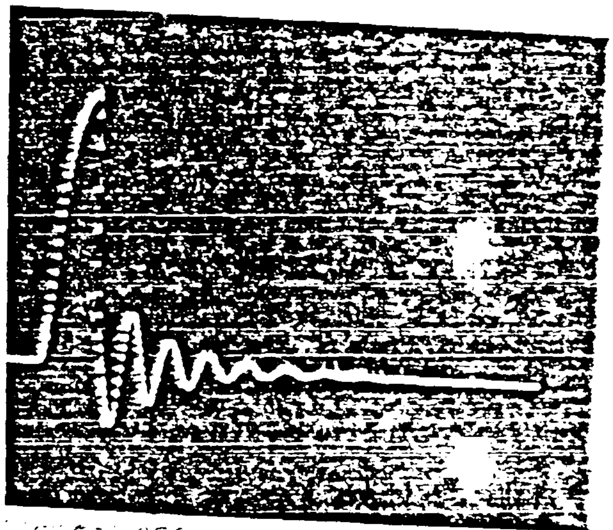
I hereby certify that this is a true report based on factory tests made in accordance with USA Standard Test Code for Distribution, Power and Regulating Transformers, C57.12 or latest revision thereof: and that each transformer withstood the above tests.

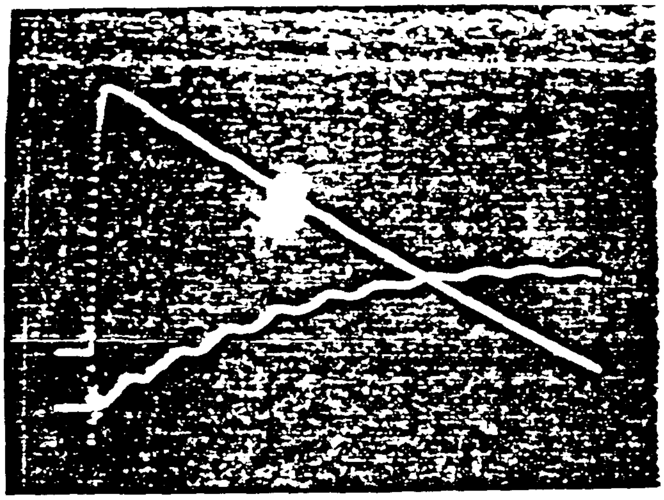
Signed: [signature] Date: 10/8/90 [signature]

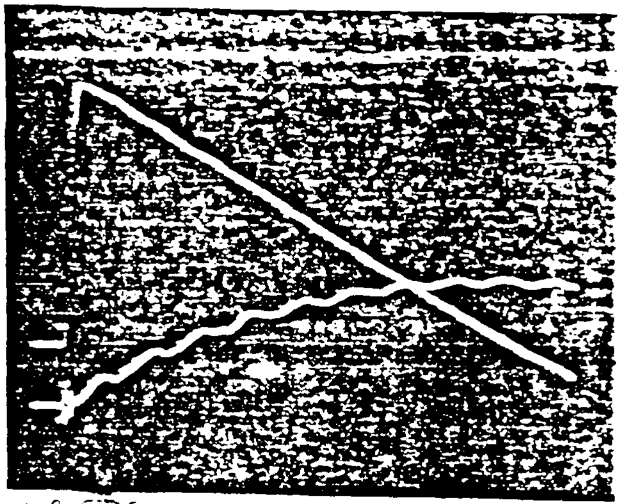


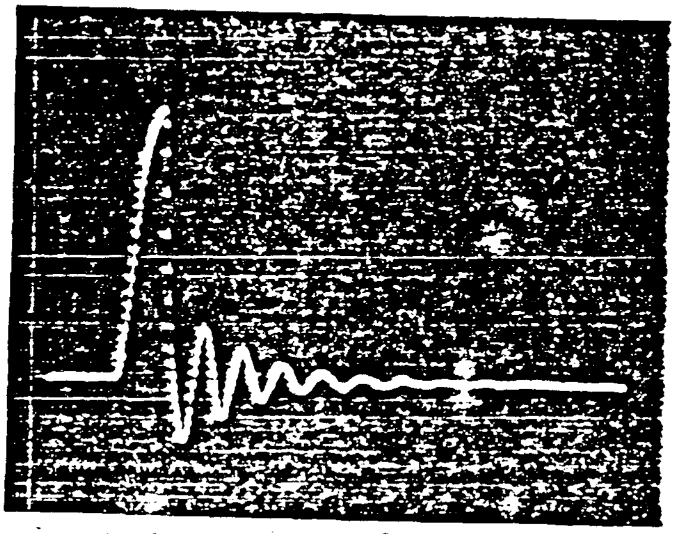


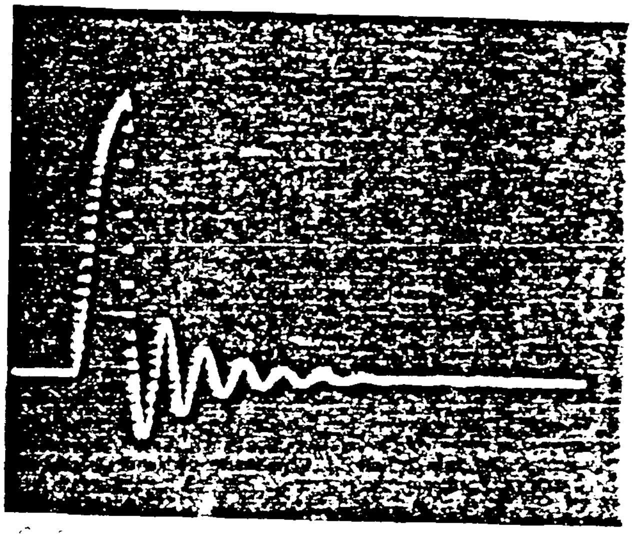


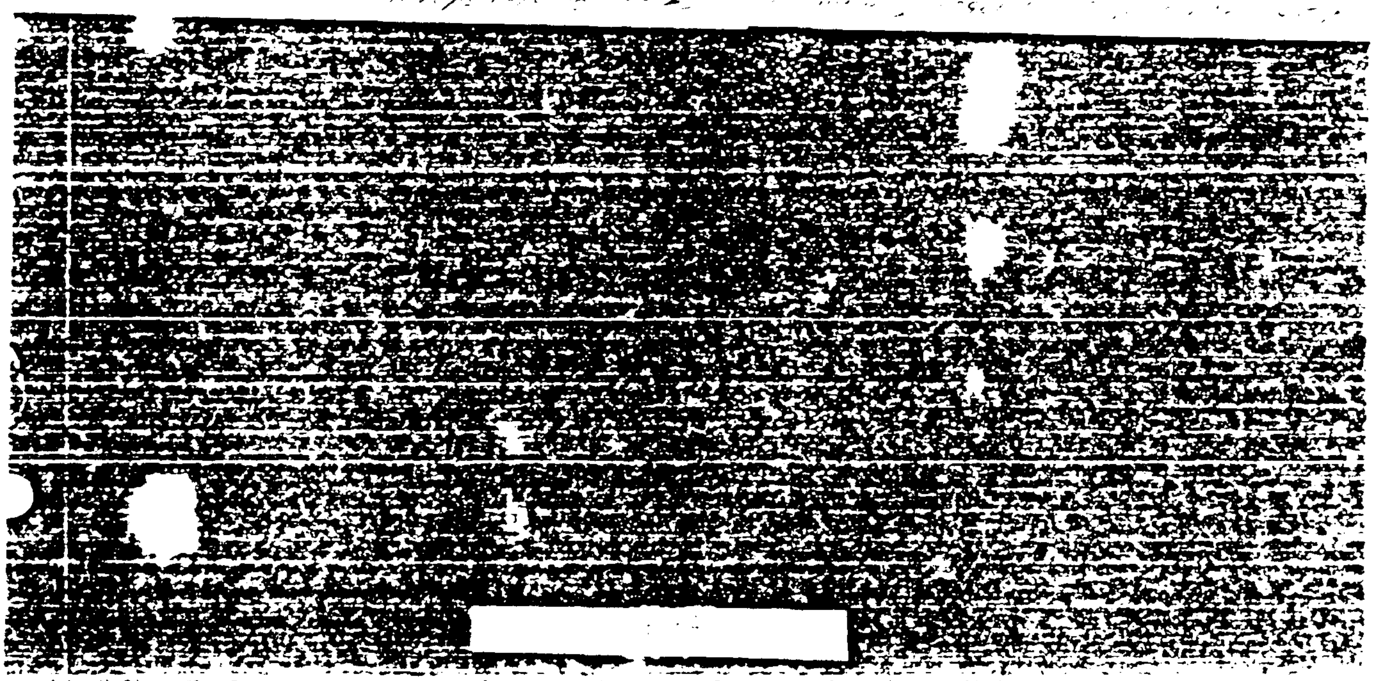


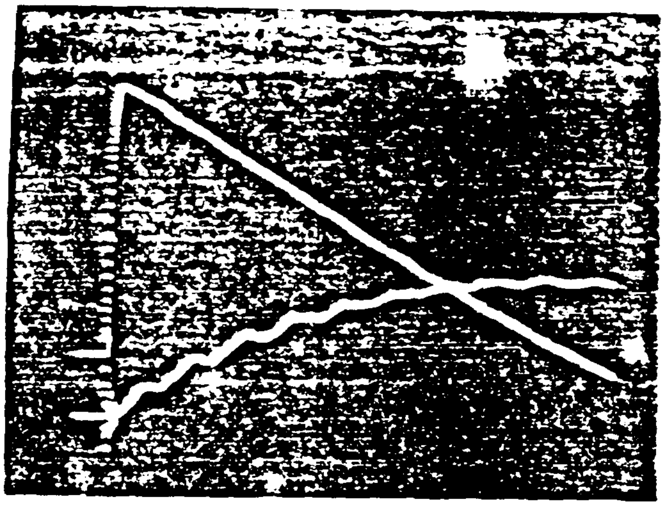


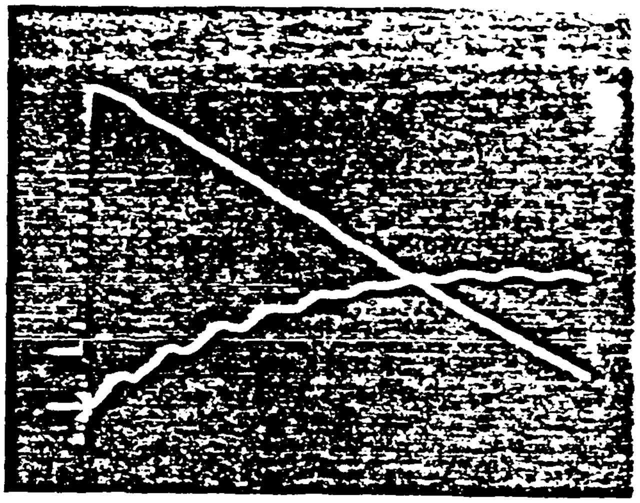


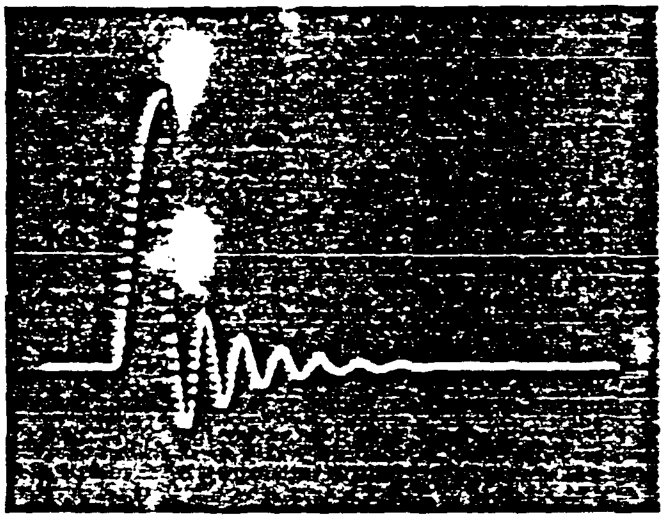


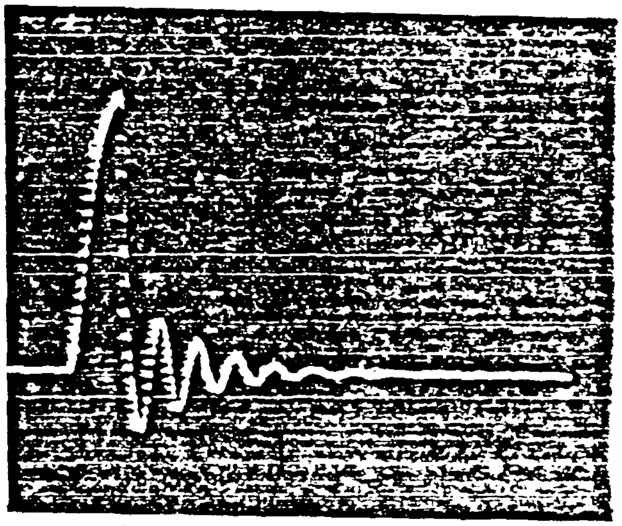












EB NATIONAL INDUSTRI

2520 58th Street
Hampton, Virginia 23661

Telephone
(804) 838-8080

Telex
82-3646

Telefax
(804) 838-8905

TRANSMITTAL LETTER

FOR

CERTIFIED TEST REPORT

RE: ABB SERVICE CO.
2382 E. ARTESIA BLVD.
LONG BEACH, CA 90805

DATE: OCT 16 1990

SHOP ORDER NO: 29020

ATTENTION: ROGER RATICAN

JOB NAME: TBA

CUSTOMER: ABB SERVICE CO

P.O.NO: LS-01446-C

We are transmitting herewith four (4) copies of the Certified Test Report for your records.

If you have any questions, please do not hesitate to contact me.

Sincerely,

Patty Dorris

Patty Dorris
Admin. Assist. Mkt.

CERTIFIED TEST REPORT

SHOP ORDER 02902-1 STYLE NO. 841500B110 TEST DATE 10-09-90

NOMINAL VOLTAGE: 12000 Delta / 480 Grd-Wye Three Phase 60 Her
KVA: 1500/2000 CLASS: AA/FFA AVG WDG RISE: 75 DEG C.
INSULATION RATED AT 185 DEGREE C BIL (kv): HV- 95 LV-

CUSTOMER: ABB SERVICE CO. PO# LS-01446-C
LONG BEACH, CA 90805

KVA	NO LOAD LOSSES 29 C (watts)	% Iex 29 C	TAP (volts)	LOAD LOSSES 95 C (watts)	% Z 95 C	TOTAL SERIES RESISTANCE @ 95 C PRIMARY (ohms)	SECONDAR (ohms)
1500	3759	0.746	12000	9428	5.77	2.40637	0.00131

APPLIED VOLTAGE HV (kv)	LV (kv)	INDUCED VOLTAGE 400 Hz, 18 SEC. (volts)	NOMINAL RATIO	
34	4	960	A/B	43.303
			C/A	43.289
			B/C	43.289

ANSI STANDARD IMPULSE TEST PERFORMED AT 95 KV BIL.

IMPEDANCE AND LOAD LOSSES AT TAPS:
(1-2) = 5.65% AND 9192 WATTS, (5-6) = 5.91% AND 9872 WATTS
PARTIAL DISCHARGE TEST PERFORMED, SEE ATTACHED FOR TEST RESULTS.
POWER FACTOR TEST PERFORMED AT 2.5 KV:
H-L = .235, H-G = .201 & L-G = .476

CERTIFICATION:

TEST TECHNICIAN [signature] ENGINEER [signature]

NATIONAL INDUSTRI TRANSFORMERS, INC.
HAMPTON, VA. 23661

PARTIAL DISCHARGE TEST DATA

SHOP ORDER 02902-1
STYLE NO. 841500B110
KVA 1500
TEST DATE OCTOBER 9, 1990

TOP	% VOLTAGE	COIL 1	COIL 2	COIL 3
INCEPTION	150	10 pc	40 pc	30 pc
EXTINCTION	110	0 pc	15 pc	10 pc

BOTTOM	% VOLTAGE	COIL 1	COIL 2	COIL 3
INCEPTION	150	20 pc	40 pc	20 pc
EXTINCTION	110	10 pc	15 pc	4 pc

NATIONAL INDUSTRI
TRANSFORMERS, INC.

2520 58th Street
Hampton, VA 23661
804) 838-8080
Telex 82-3646

ISSUED 9-7-79
REVISED 12-9-8
SECTION 8-7

TRANSFORMER IMPUSE TEST REPORT

Purchaser T.E.P. STANTLE CO.

Date of Test 10/10/90 Purchaser's Order No. LS-N44E-C Mfr's. Ref. 84-150

Type CAST/CAST Phase 3 Hertz 60 Insulating Fluid

H Winding 1500 KVA X Winding 1500 KVA Y Winding KVA

12000 DELTA Volts 480 GRDY/277 Volts Volts

95K BIL 30K BIL BIL

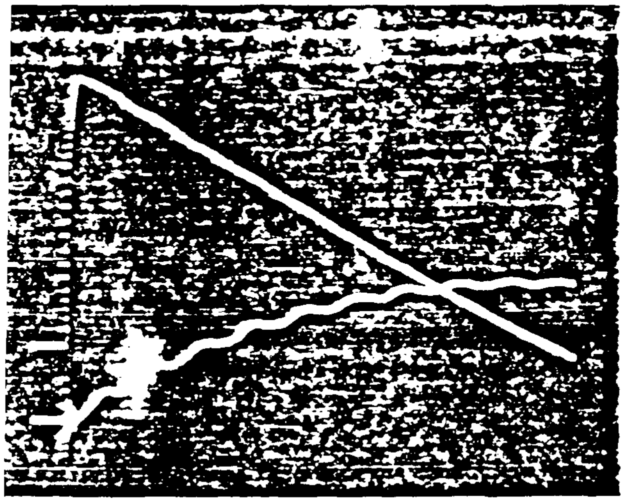
Serial No.	Terminal Surged	Test*	Crest Voltage KV	Wave Shape of Rate of Rise	Time to Flashover	Oscillogram Number	Sweep Time or Timing Wave Freq. N Sec.	Co...
C2902-1	H-1	RFWV	47.5	1.25/43µs		1	10	Gro...
|	|	RFWC				1C	5	Cur...
|	|	CWV	95		1.85µs	2	2	
|	|	CWV	95		2.0µs	3	2	
|	|	FWV	95	1.25/43µs		4		
|	V	FWC				4C	10	
|	H-2	RFWV	47.5	1.25/43µs		5	10	
|	|	RFWC				5C	10	
|		CWV	95		2.15µs	6	2	
|	|	CWV	95		1.90µs	7	2	
|	|	FWV	95	1.25/43µs		8	10	
|	V	FWC				8C	10	
|	H-3	RFWV	47.5	1.25/43µs		9	10	
|	.	RFWC				9C	10	
|	|	CWV	95		1.85µs	10	2	
|	|	CWV	95		1.70µs	11	2	
|	|	FWV	95	1.25/43µs		12	10	
V	V	FWC				12C	10	

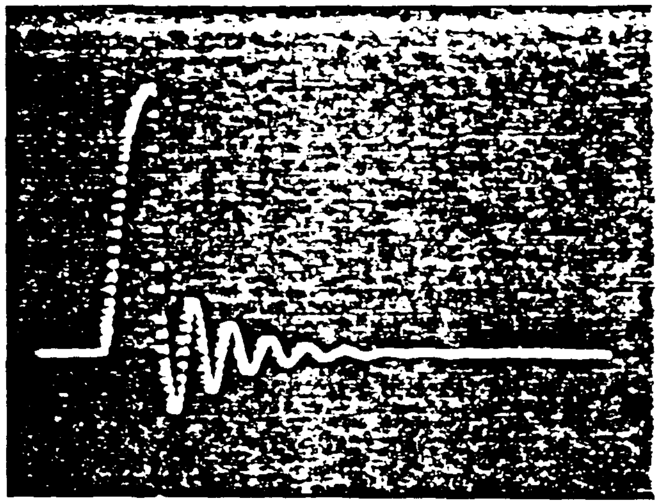
* RFWV Reduced Full-Wave Voltage, RFWC Reduced Full-Wave Current, FWV Full-Wave Voltage, FWC Full-Wa... Current, CWV Chopped-Wave Voltage, FOW Front of Wave Voltage.
GRD Terminals grounded, ARR Terminals connected to arresters, RES Terminals connected to ground through lin... resistance.

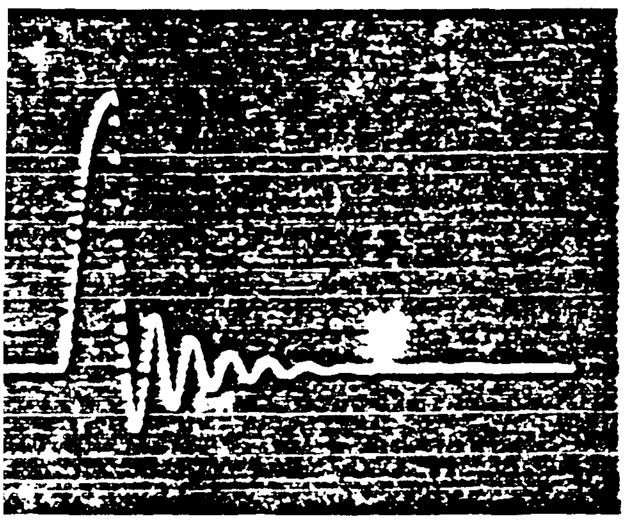
Tests Witnessed by Scott McBride (EG&E)

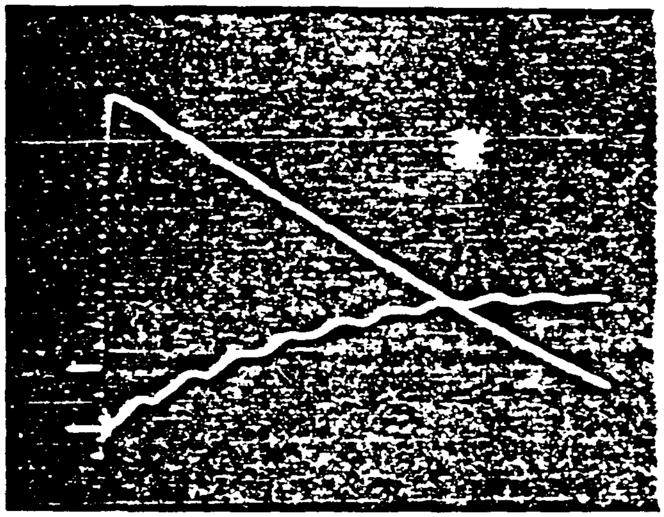
I hereby certify that this is a true report based on factory tests made in accordance with USA Standa... est Code Distribution, Power and Regulating Transformers, C57.12 or latest revision thereof; and that each transformer withst... the above tests.

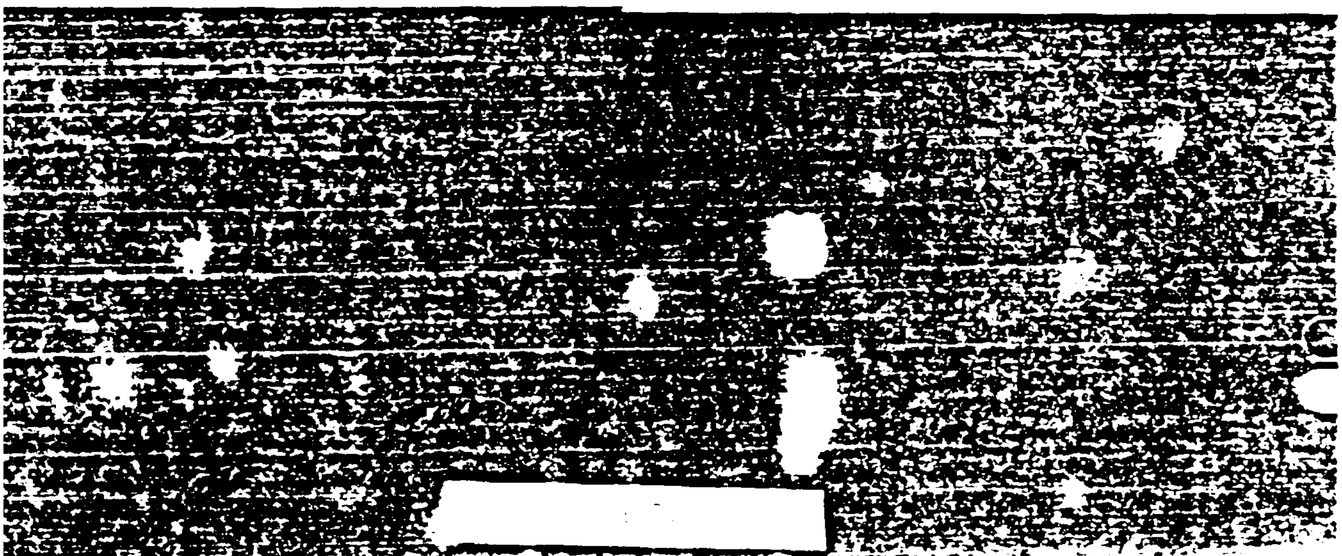
Signed Tim Adams Date 10/10/90 Approved Bill d'O...

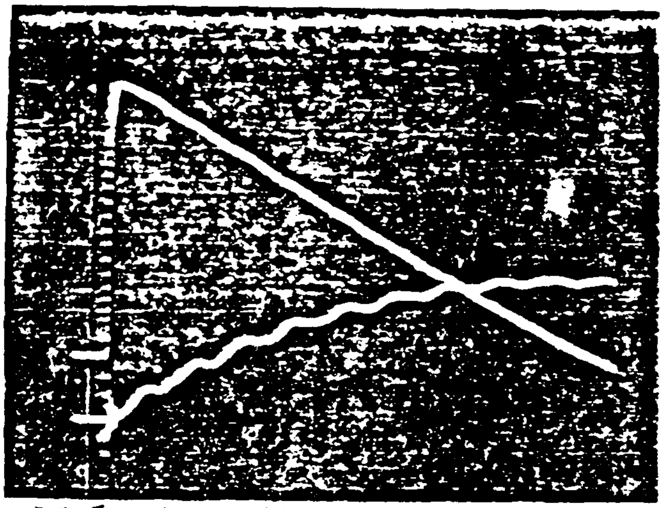
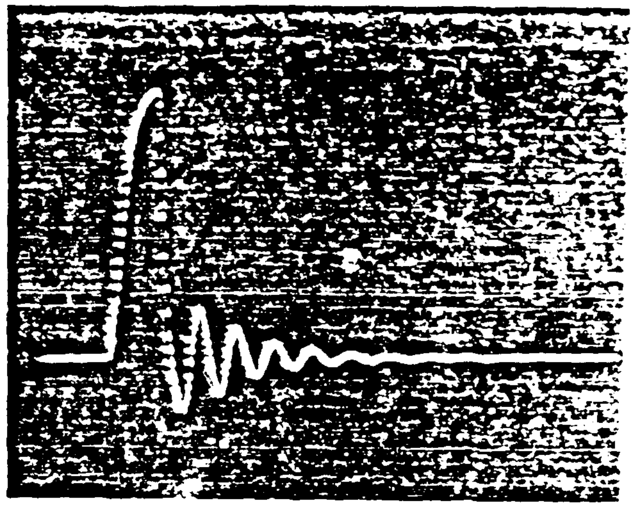
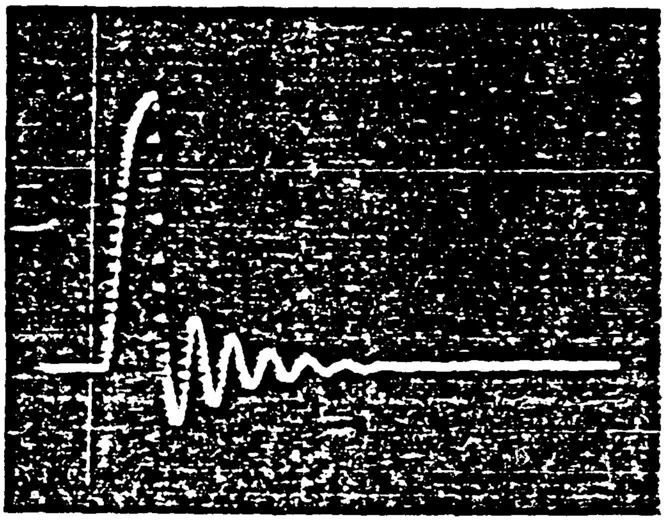
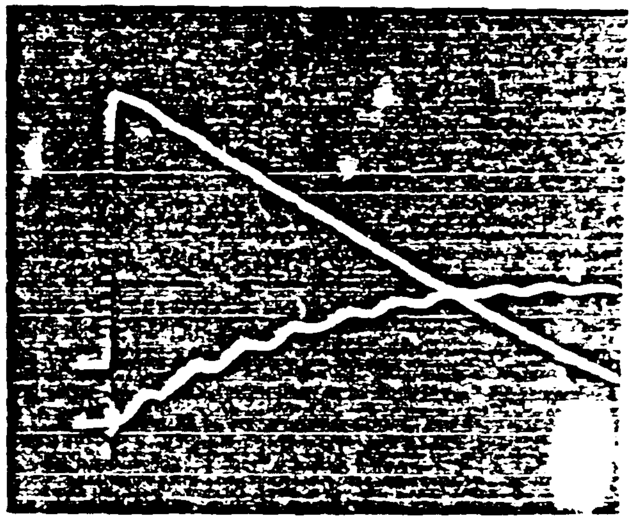


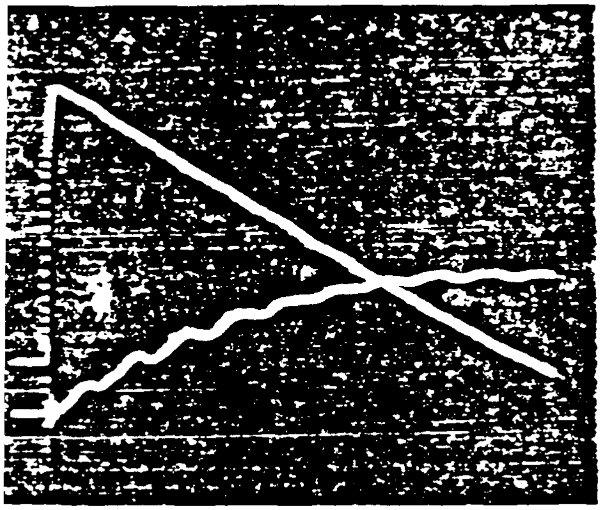


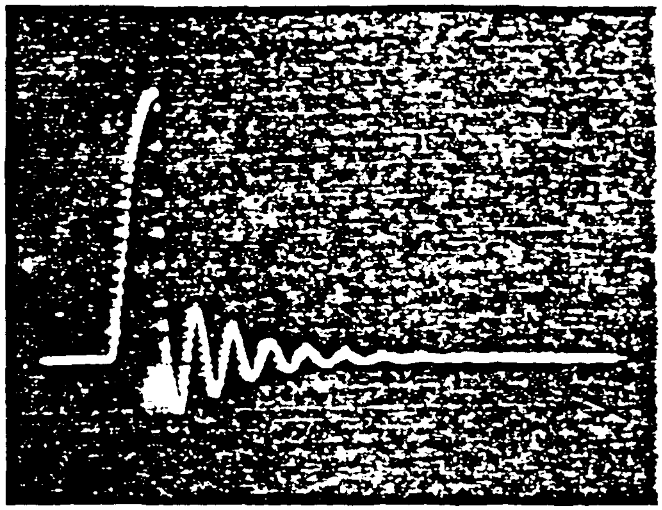


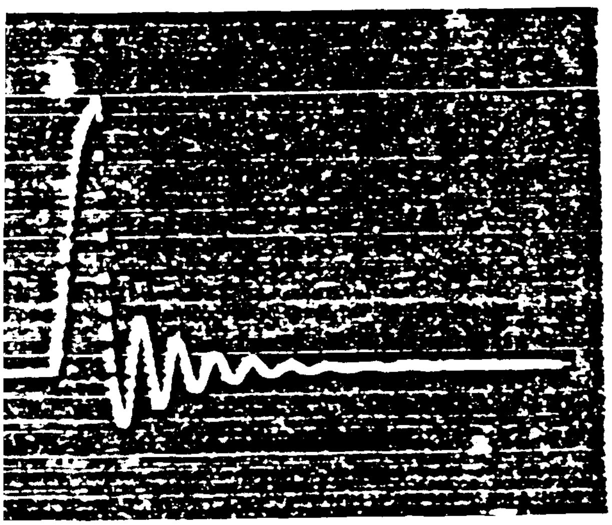


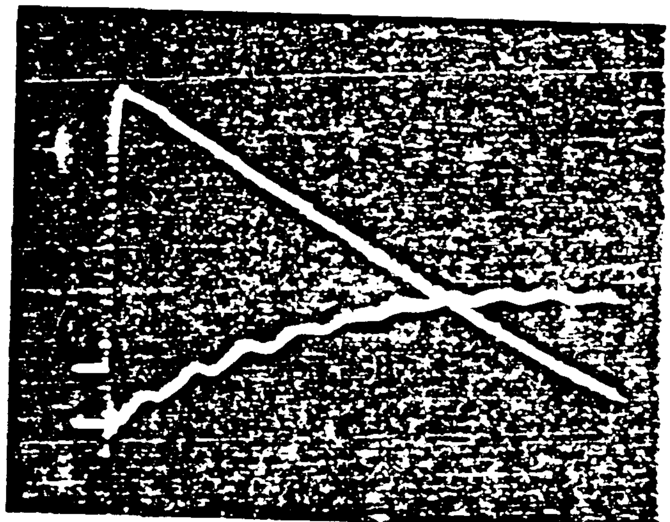


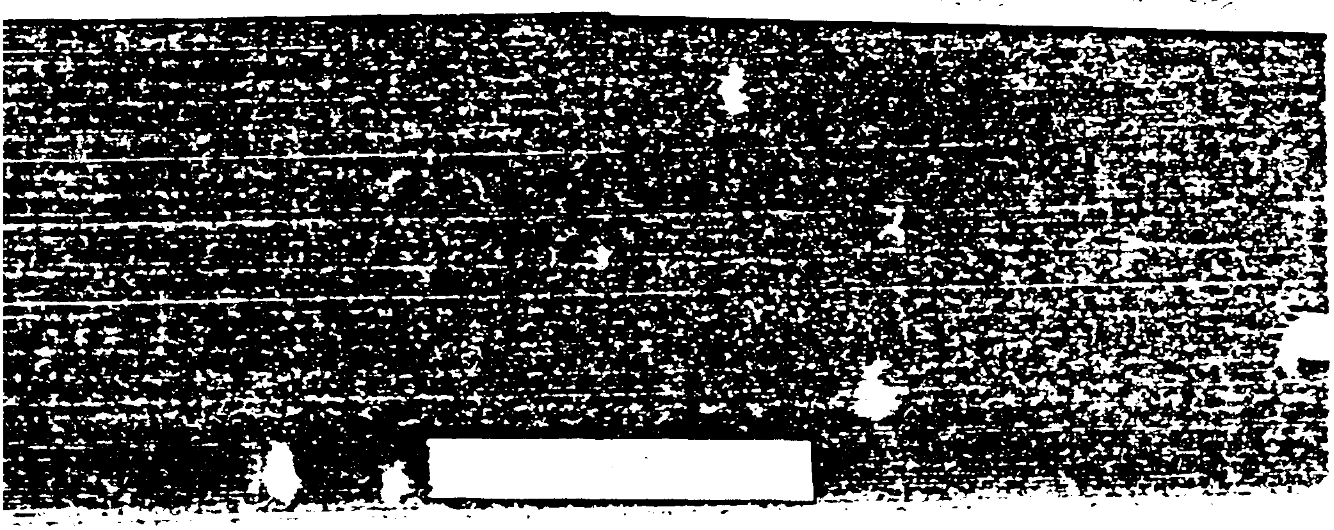















CERTIFIED TEST REPORT

SHOP ORDER 02904-1 STYLE NO. 840500B050 TEST DATE 09-19-90

NOMINAL VOLTAGE: 12000 Delta / 480 Grd-Wye Three Phase 60 Hert:
KVA: 500/666 CLASS: AA/FFA AVG WDG RISE: 75 DEG C.
INSULATION RATED AT 185 DEGREE C BIL (kv): HV- 95 LV- 3(

CUSTOMER: ABB SERVICE CO.
LONG BEACH, CA. 90805
PO# LS-01446-C

KVA	NO LOAD LOSSES 26 C (watts)	% Iex 26 C	TAP (volts)	LOAD LOSSES 95 C (watts)	% Z 95 C	TOTAL SERIES RESISTANCE @ 95 C PRIMARY (ohms)	SECONDARY (ohms)
500	2244	1.689	12000	4499	5.57	13.50484	0.004515

APPLIED VOLTAGE HV (kv)	LV (kv)	INDUCED VOLTAGE 400 Hz, 18 SEC. (volts)	NOMINAL RATIO	
34	4	960	A/B	43.267
			C/A	43.253
			B/C	43.260

ANSI STANDARD IMPULSE TEST PERFORMED AT 95 KV BIL.

AA MEASURED TEMPERATURE RISE (C): HV - 66.6 LV - 54.0

IMPEDANCE AND LOAD LOSSES AT TAPS:
(1-2) = 5.51% AND 4344 WATTS, (5-6) = 5.73% = 4638 WATTS
PARTIAL DISCHARGE TEST PERFORMED, SEE ATTACHED FOR TEST RESULTS.
POWER FACTOR TEST PERFORMED AT 2.5 KV:
H-L = .186, H-G = .182 & L-G = .677

CERTIFICATION:

TEST TECHNICIAN ______ ENGINEER ______

NATIONAL INDUSTRI TRANSFORMERS, INC.
HAMPTON, VA. 23661

EB NATIONAL INDUSTRI
2520 58th Street
Hampton, Virginia 23661
Telephone (804) 838-8080
Telex 82-3646
Telefax (804) 838-8905

TRANSMITTAL LETTER

FOR

CERTIFIED TEST REPORT

RE: ABB SERVICE CO.
2382 E. ARTESIA BLVD.
LONG BEACH, CA 90805

DATE: OCT 16 1990

SHOP ORDER NO: 29040

ATTENTION: ROGER RATICAN

JOB NAME: TBA

CUSTOMER: ABB SERVICE CO

P.O.NO: LS-01446-C

We are transmitting herewith four (4) copies of the Certified Test Report for your records.

If you have any questions, please do not hesitate to contact me.

Sincerely,

Patty Dorris

Patty Dorris
Admin. Assist. Mkt.

PARTIAL DISCHARGE TEST DATA

SHOP ORDER 02904-1
STYLE NO. 840500B050
KVA 500
TEST DATE OCTOBER 11, 1990

TOP	% VOLTAGE	COIL 1	COIL 2	COIL 3
INCEPTION	150	3 pc	5 pc	15 pc
EXTINCTION	110	0 pc	5 pc	0 pc

BOTTOM	% VOLTAGE	COIL 1	COIL 2	COIL 3
INCEPTION	150	3 pc	5 pc	15 pc
EXTINCTION	110	0 pc	5 pc	0 pc

NATIONAL INDUSTRI
TRANSFORMERS, INC.

2520 58th Street
Hampton, VA 23661
804-838-8080
Telex 82-3646

ISSUED 9/7/79
REVISED 10/5/83
SECTION B-7

TRANSFORMER IMPULSE TEST REPORT

Purchaser ABB Service Co.

Date of Test 10/11/90 Purchaser's Order No. LS-01446-C Mfr's. Ref. 84-A500-B050

Type CAST/CAST Phase 3 Hertz 60 Insulating Fluid ______

H Winding 500 KVA X Winding 500 KVA Y Winding ______ KVA

12000 DELTA Volts 480 GRDY/277 Volts ______ Volts

95 K BIL 30 KV BIL ______ BIL

Serial No.	Terminal Surged	Test*	Crest Voltage KV	Wave Shape of Rate of Rise	Time to Flashover	Oscillogram Number	Sweep Time or Timing Wave Freq. μ Sec.	Connec. of Untested Winding Terminals
904-1	H-1	RFWV	475	1.25/50 μs		1	10	Grounded
		RFWC				1c	10	Current Shunt
		CWV	95		2.05 μs	2	2	
		CWV	95		1.85 μs	3	2	
		FWV	95	1.25/50 μs		4	10	
		FWC				4c	10	
	H-2	RFWV	47.5	1.25/50 μs		5	10	
		RFWC				5c	10	
		CWV	95		2.05 μs	6	2	
		CWV	95		2.15 μs	7	2	
		FWV	95	1.25/50 μs		8	10	
		FWC				8c	10	
	H-3	RFWV	475	1.25/50 μs		9	10	
		RFWC				9c	10	
		CWV	95		2.05 μs	10	2	
		CWV	95		1.90 μs	11	2	
		FWV	95	1.25/50 μs		12	10	
		FWC				12c	10	

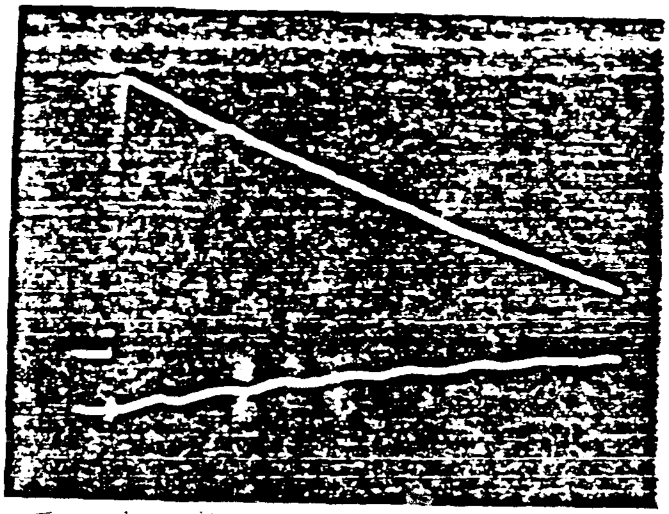
* RFWV Reduced Full-Wave Voltage, RFWC Reduced Full-Wave Current, FWV Full-Wave Voltage, FWC Full-Wave Current, CWV Chopped-Wave Voltage, FCWV Front of Wave Voltage.

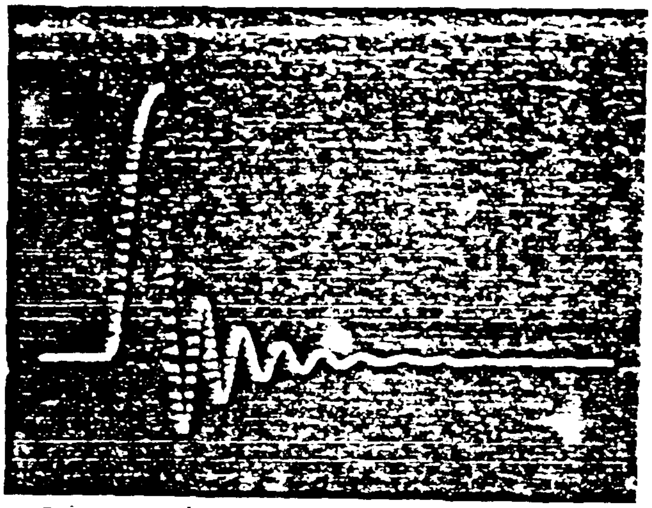
GRD Terminals grounded, ARR Terminals connected to arresters, RES Terminals connected to ground through linear resistance.

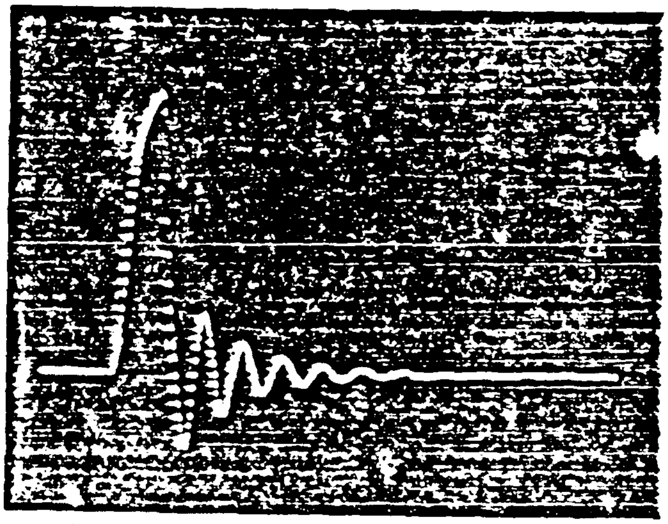
Tests Witnessed by Scott McBride (FFAE)

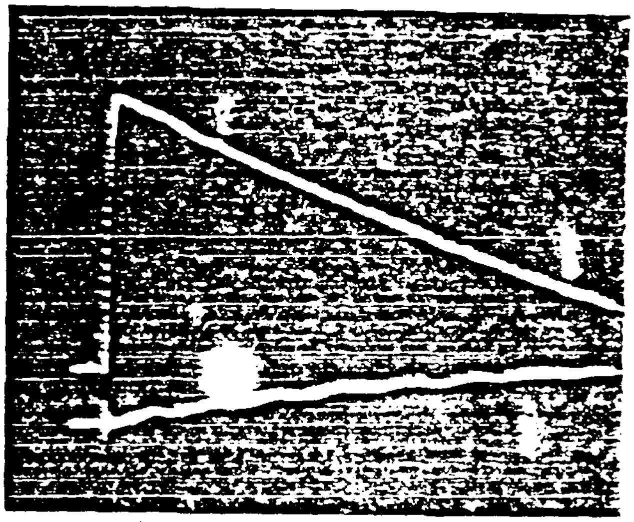
I hereby certify that this is a true report based on factory tests made in accordance with USA Standard Test Code for Distribution, Power and Regulating Transformers, C57.12 or latest revision thereof; and that each transformer withstood the above tests.

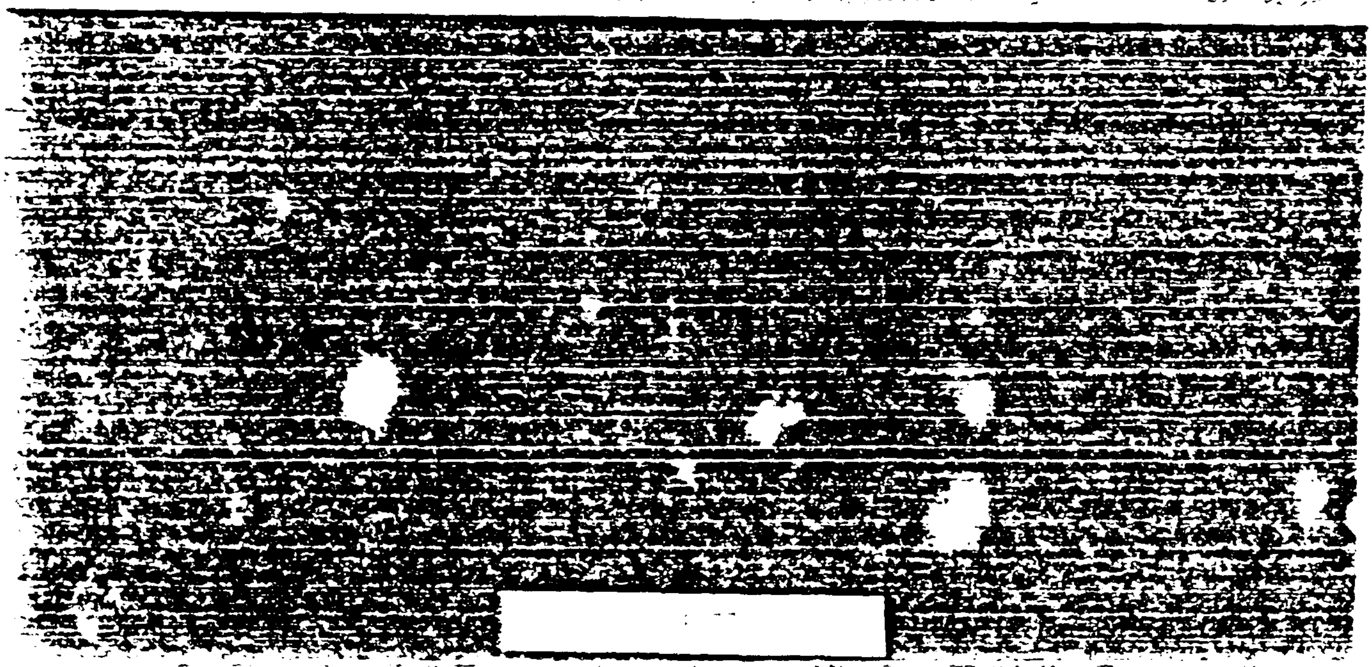
Signed Tom [illegible] Date 10/11/90

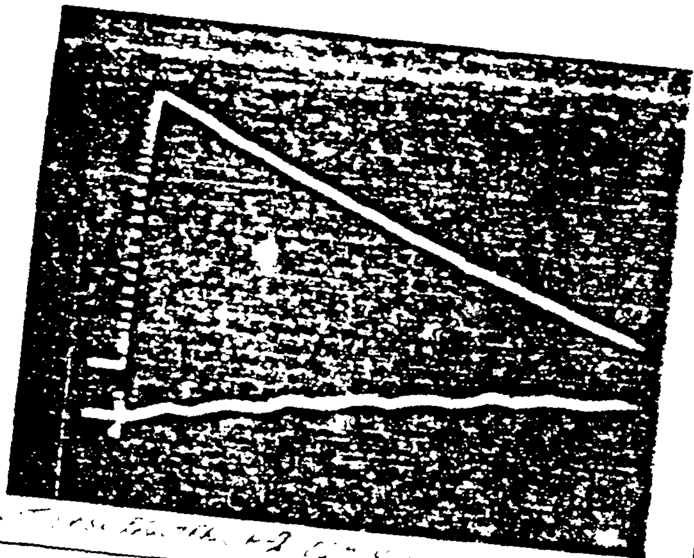


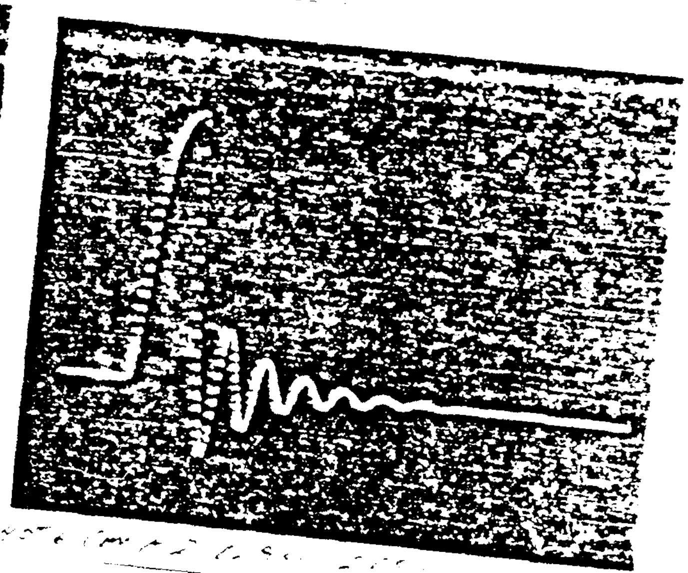


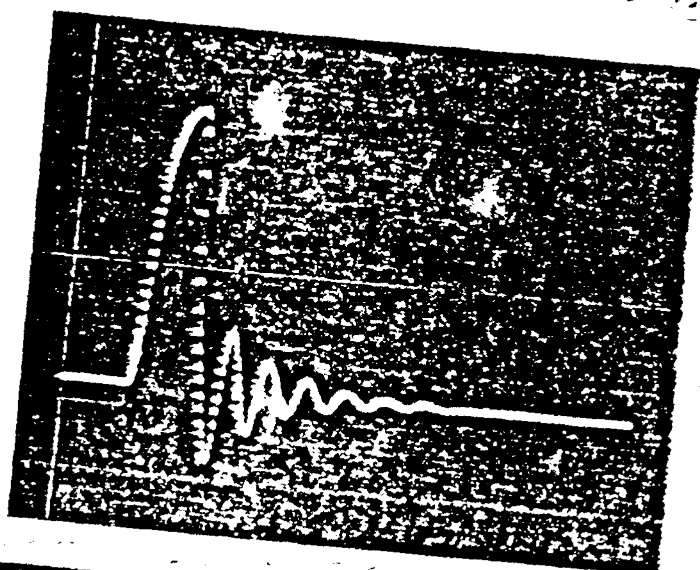


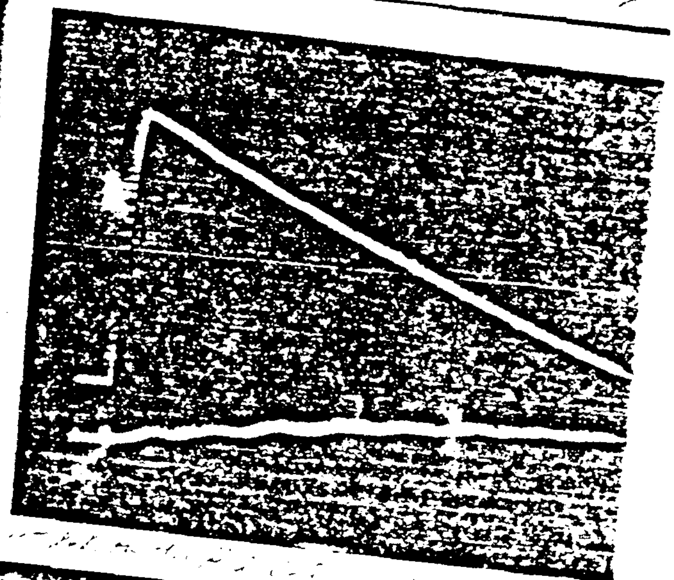


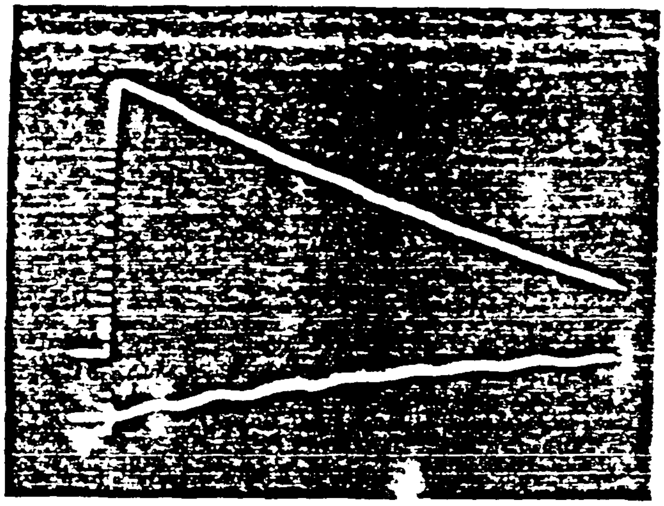


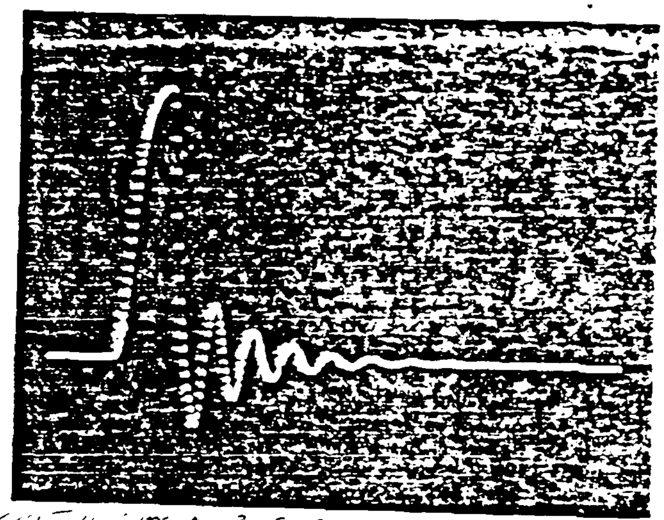


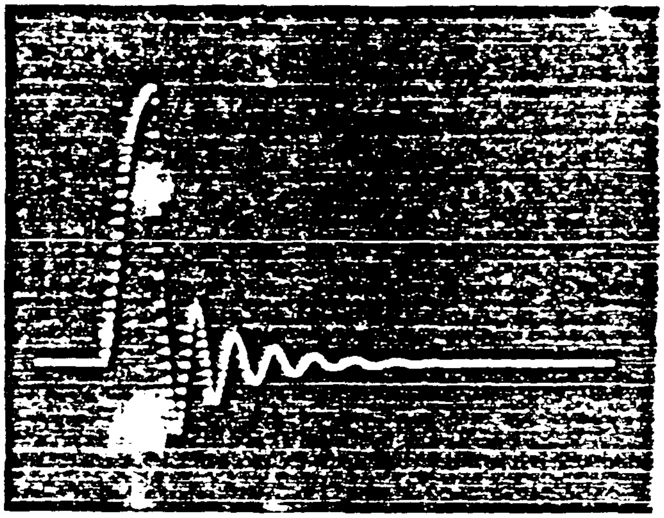


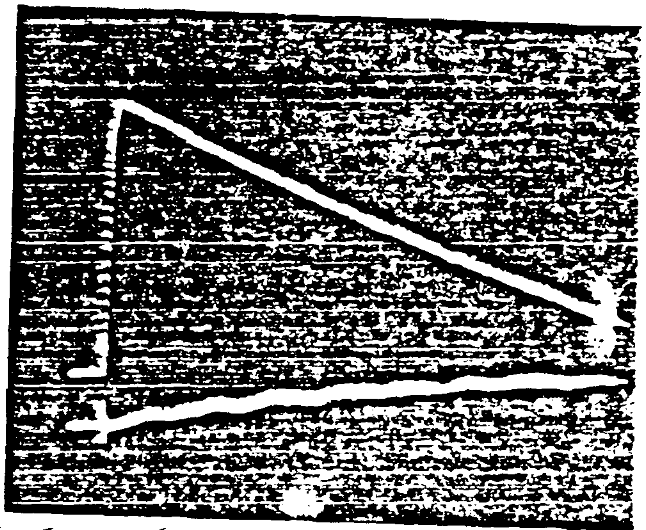


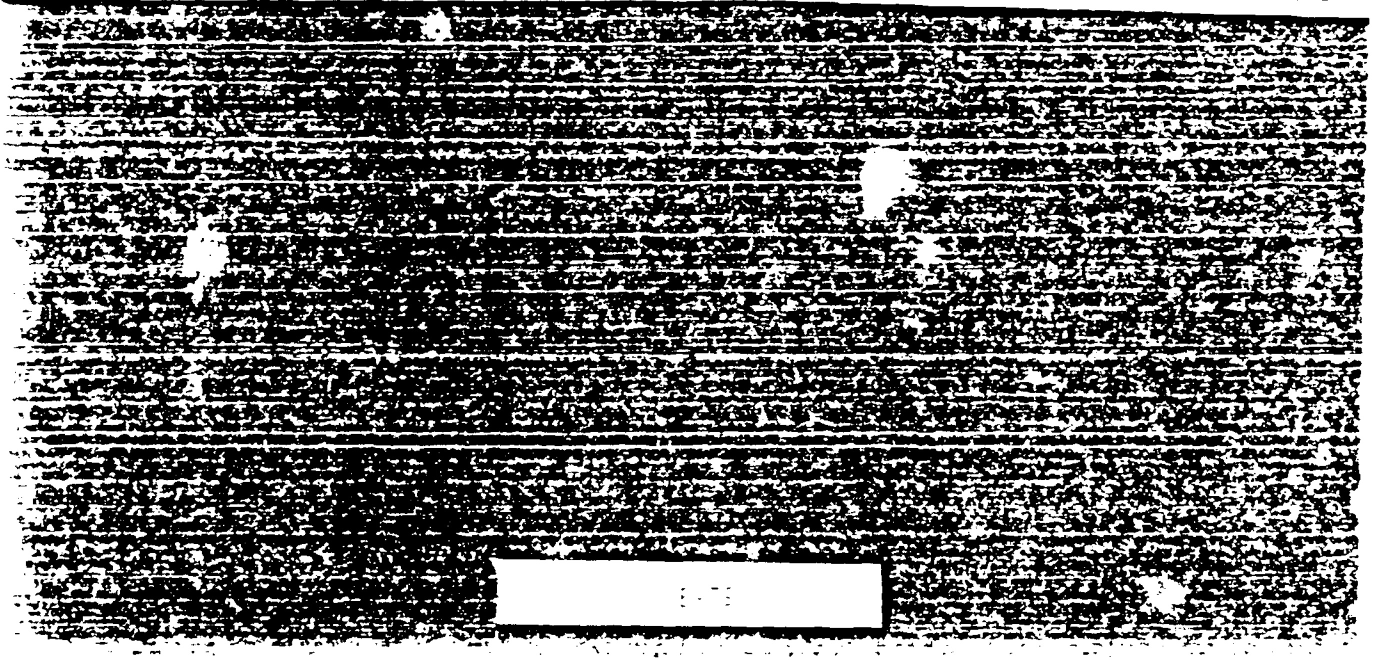












THREE PHASE
INSULATED TRANSFORMER

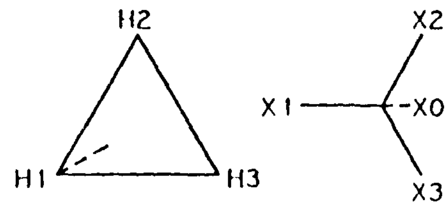
QUIET QUALITY®

SORGEL® TRANSFORMERS
SQUARE D COMPANY
MADE IN U.S.A.

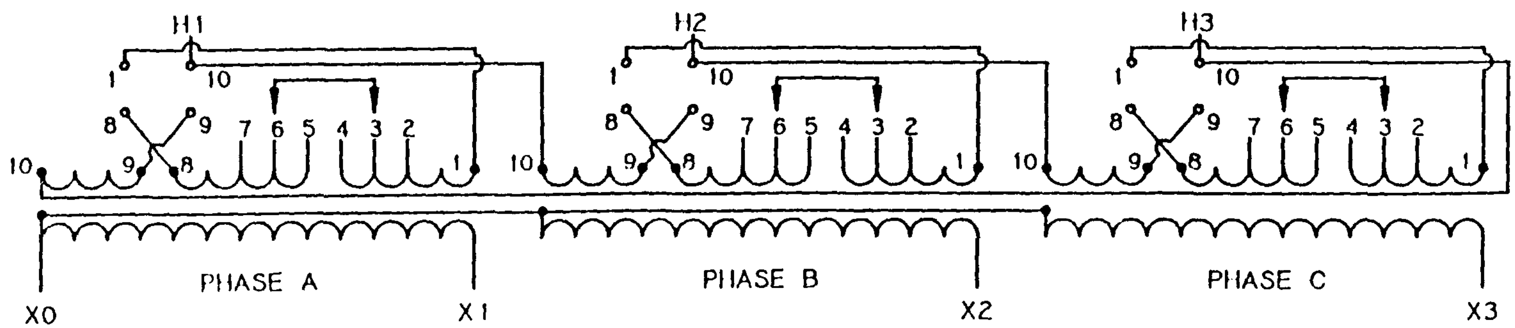
CONNECTIONS				
2400 DELTA		12000 DELTA		CONNECT IN EACH PHASE
VOLTS	AMPERES	VOLTS	AMPERES	
2400	72.0	12600	13.7	4 TO 5
		12300	14.1	4 TO 6
		12000	14.4	3 TO 6
		11700	14.8	3 TO 7
		11400	15.2	2 TO 7
LOW VOLTAGE: 480Y/277		AMPERES: 360		

HIGH VOLTAGE TERMINAL BOARD CONNECTIONS	
2400 DELTA	12000 DELTA
1 o o 10 8 o o 9	1 o———o 10 8 o———o 9

SERIAL NO.: 206105
KVA 300 CLASS AA/FFA
TYPE SHT HERTZ 60
IMPEDANCE %
220°C INSULATION SYSTEM FOR 80 °C RISE.
H.V. B.I.L. 60 KV
L.V. B.I.L. 10 KV
APPROX. WEIGHT 4600 LBS.

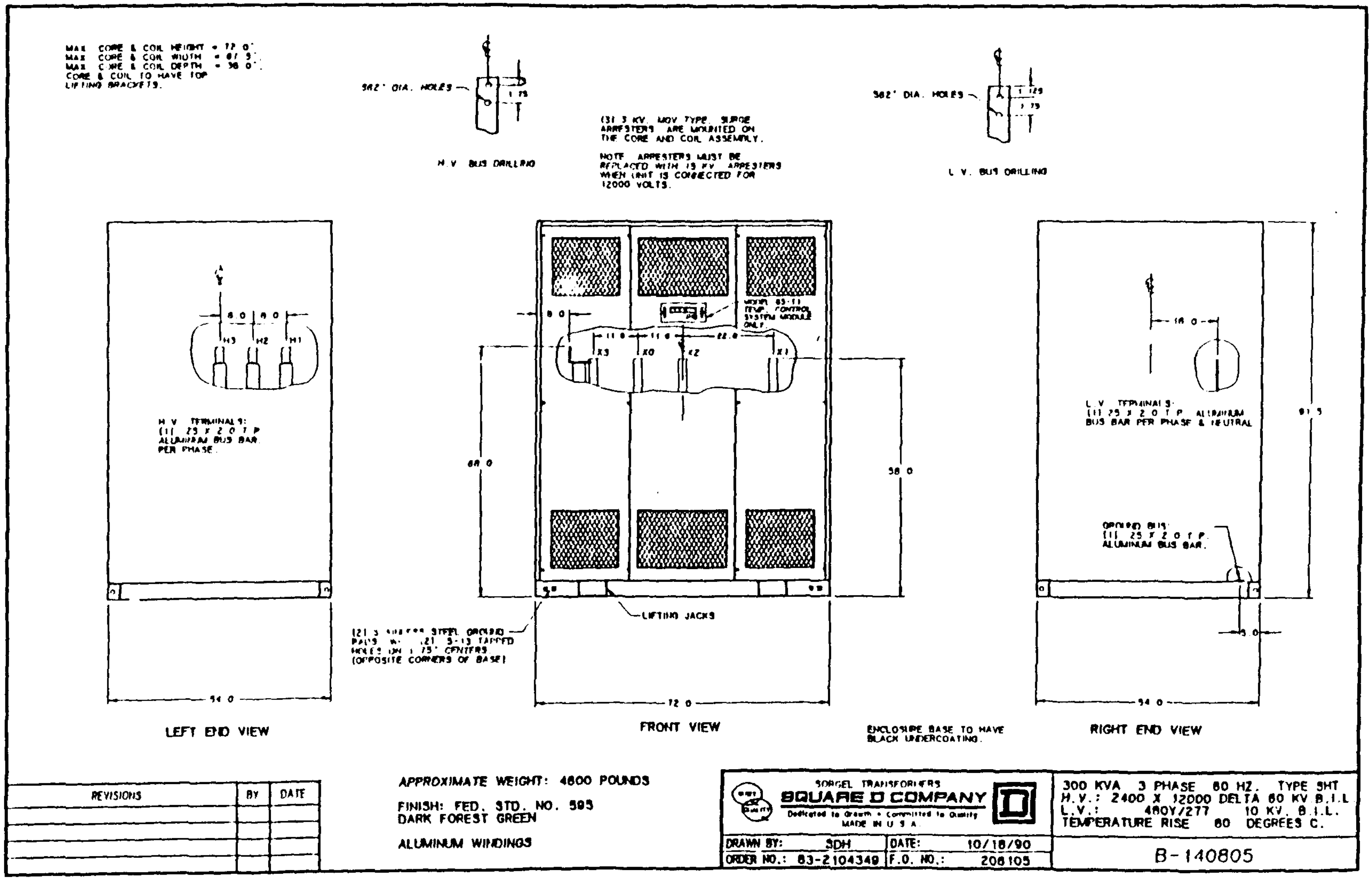


POLARITY

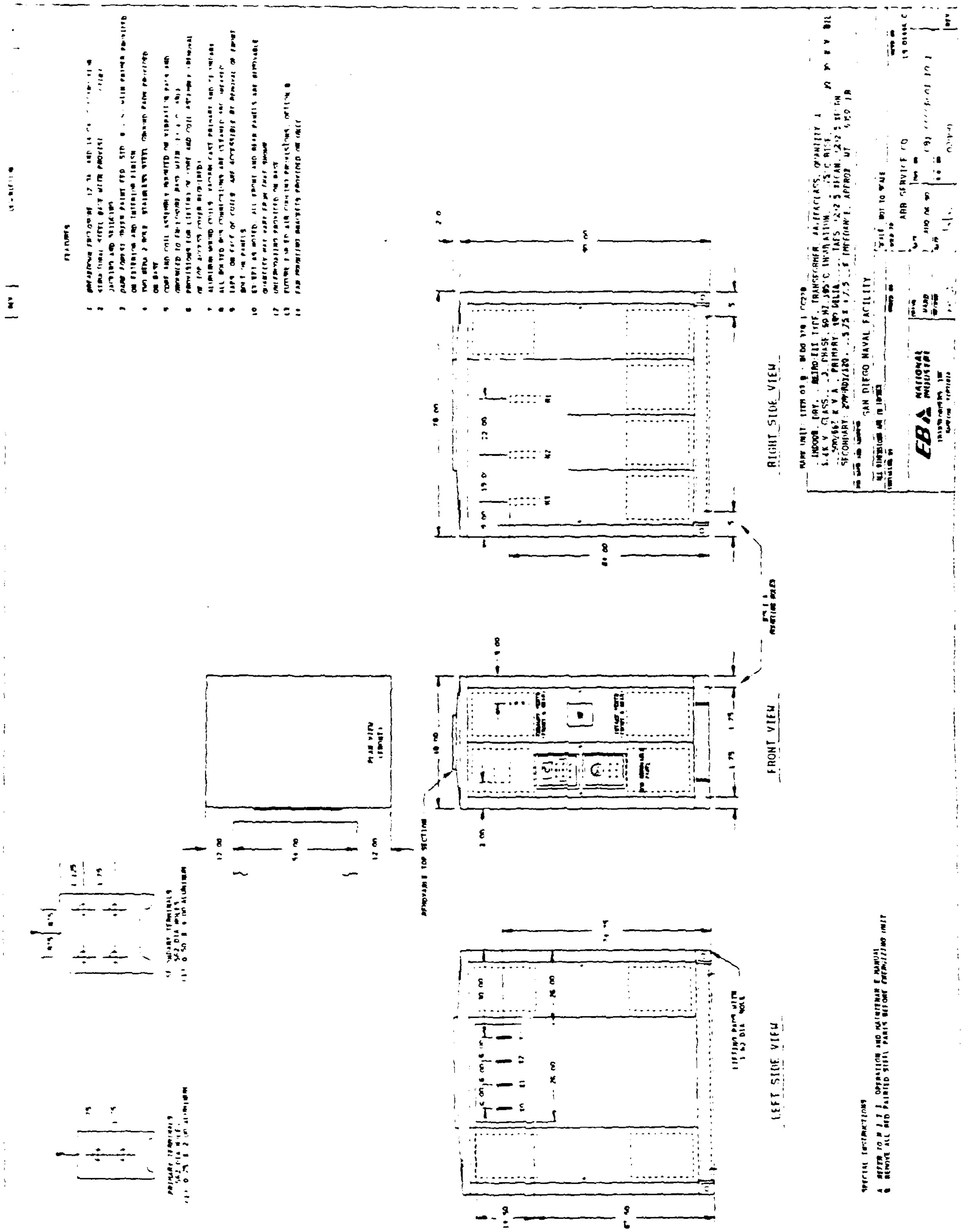


DE-ENERGIZE TRANSFORMER BEFORE CHANGING TAPS.

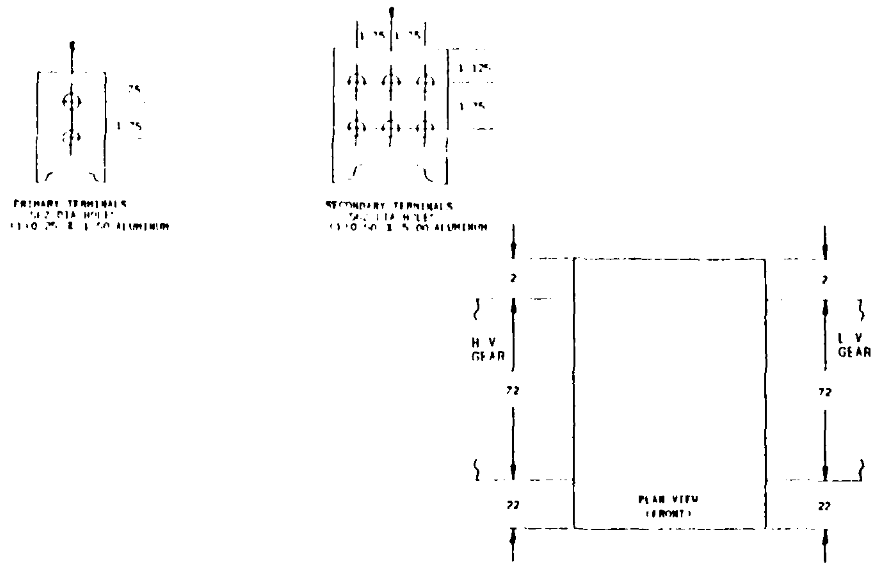
B-137489



MAX CORE & COIL HEIGHT = 72.0"
MAX CORE & COIL WIDTH = 67.5"
MAX CORE & COIL DEPTH = 38.0"
CORE & COIL TO HAVE TOP LIFTING BRACKETS.
.562" DIA. HOLES
H.V. BUS DRILLING
(3) 3 KV. MOV TYPE SURGE ARRESTERS ARE MOUNTED ON THE CORE AND COIL ASSEMBLY.
NOTE: ARRESTERS MUST BE REPLACED WITH 15 KV. ARRESTERS WHEN UNIT IS CONNECTED FOR 12000 VOLTS.
.562" DIA. HOLES
L.V. BUS DRILLING
H.V. TERMINALS: (1) .25 X 2.0 T.P. ALUMINUM BUS BAR PER PHASE.
L.V. TERMINALS: (1) .25 X 2.0 T.P. ALUMINUM BUS BAR PER PHASE & NEUTRAL
GROUND BUS: (1) .25 X 2.0 T.P. ALUMINUM BUS BAR.
LIFTING JACKS
(2) STEEL GROUND PADS W/ (2) .5-13 TAPPED HOLES ON 1.75" CENTERS (OPPOSITE CORNERS OF BASE)
LEFT END VIEW
FRONT VIEW
ENCLOSURE BASE TO HAVE BLACK UNDERCOATING.
RIGHT END VIEW
REVISIONS
BY
DATE
APPROXIMATE WEIGHT: 4600 POUNDS
FINISH: FED. STD. NO. 595 DARK FOREST GREEN
ALUMINUM WINDINGS
SORGEL TRANSFORMERS
SQUARE D COMPANY
MADE IN U.S.A.
DRAWN BY: SDH
DATE: 10/18/90
ORDER NO.: 83-2104349
F.O. NO.: 208105
300 KVA 3 PHASE 60 HZ. TYPE SHT
H.V.: 2400 X 12000 DELTA 60 KV B.I.L.
L.V.: 480Y/277 10 KV. B.I.L.
TEMPERATURE RISE 80 DEGREES C.
B-140805

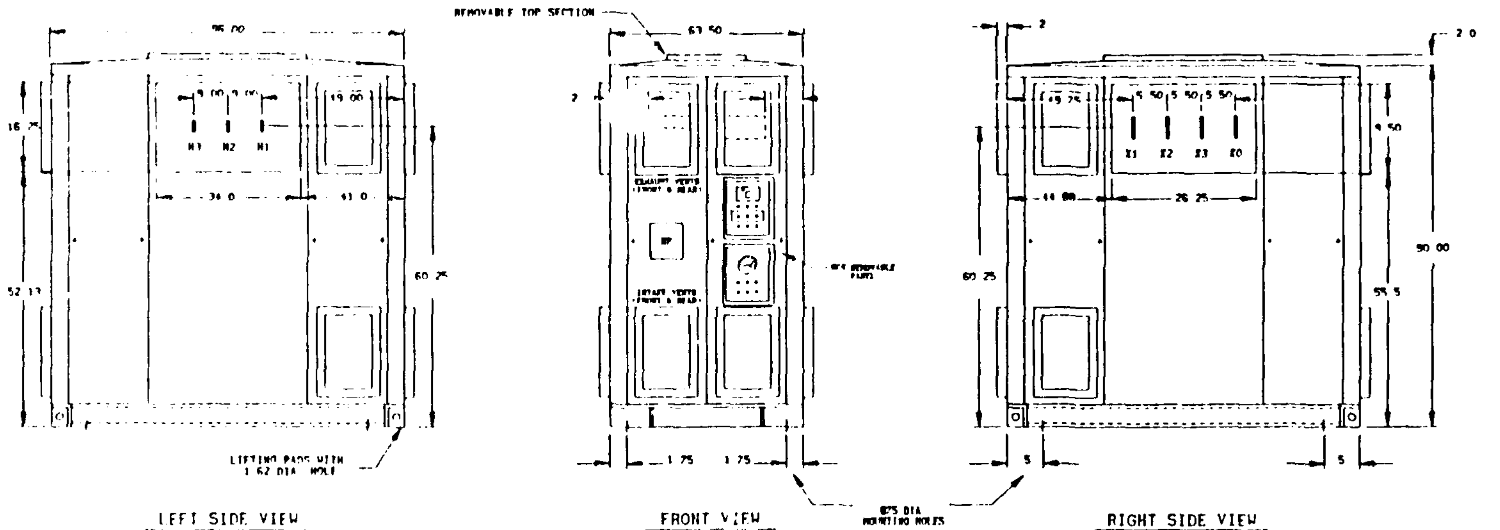

RIGHT SIDE VIEW
FRONT VIEW
LEFT SIDE VIEW
PLAN VIEW
REMOVABLE TOP SECTION
SAN DIEGO NAVAL FACILITY
ABB SERVICE CO

REV	DESCRIPTION	DATE	BY
1	CHANGED NOTE 3	AUG 10 90	WHITE
2	CHANGED NOTE #11	OCT 03 90	RAY



FEATURES

1 BREAKDOWN ENCLOSURE, 12 GA. AND 14 GA. CONSTRUCTION
2 STRUCTURAL STEEL BASE WITH PROVISIONS FOR LIFTING, JACKING AND SKIDDING
3 DARK FOREST GREEN PAINT FED. STD. 595a 83408 WITH PRIMER PROVIDED ON EXTERIOR AND INTERIOR FINISH
4 TWO NEMA 2-HOLE, STAINLESS STEEL GROUND PADS PROVIDED ON BASE
5 CORE AND COIL ASSEMBLY MOUNTED ON VIBRATION PADS AND GROUNDED TO ENCLOSURE BASE WITH (1) 4/0 CABLE
6 PROVISIONS FOR LIFTING OF CORE AND COIL ASSEMBLY (REMOVAL OF TOP ACCESS COVER REQUIRED)
7 ALUMINUM WOUND COILS, VACUUM CAST PRIMARY AND SECONDARY
8 ALL BOLTED BUS CONNECTIONS ARE CLEANED AND GREASED
9 TAPS, ON FACE OF COILS, ARE ACCESSIBLE BY REMOVAL OF FRONT BOLT ON PANELS
10 EXCEPT AS NOTED, ALL FRONT AND REAR PANELS ARE REMOVABLE, QUANTITY MAY VARY FROM THAT SHOWN
11 SINGLE PHASE ANALOG FORCED AIR COOLING CONTROL, LESS FANS MOTORS, AND CPT. THREE PHASE TEMPERATURE MONITORING PROVIDED
12 UNDERCOATING PROVIDED ON BASE



SPECIAL INSTRUCTIONS

A REFER TO N.E.T.I. OPERATION AND MAINTENANCE MANUAL
B REMOVE ALL RED PAINTED STEEL PARTS BEFORE ENERGIZING UNIT

MARK UNIT: ITEM 04 - BLDG 472-CC45

OUTDOOR, DRY, RETRO-FIT TYPE, TRANSFORMER, AA/FFA CLASS, QUANTITY 1,
15K V. CLASS, 3 PHASE, 60 HZ, 185°C INSULATION, 75°C RISE, 95/30 K V BIL
1500/2000 K V A., PRIMARY: 12000 DELTA, TAPS: (2) 2.5 % FCAN, (2) 2.5 % FCBN
SECONDARY: 480GRDY/277, 5.75 % ± 7.5 % IMPEDANCE, APPROX WT 12790 LB

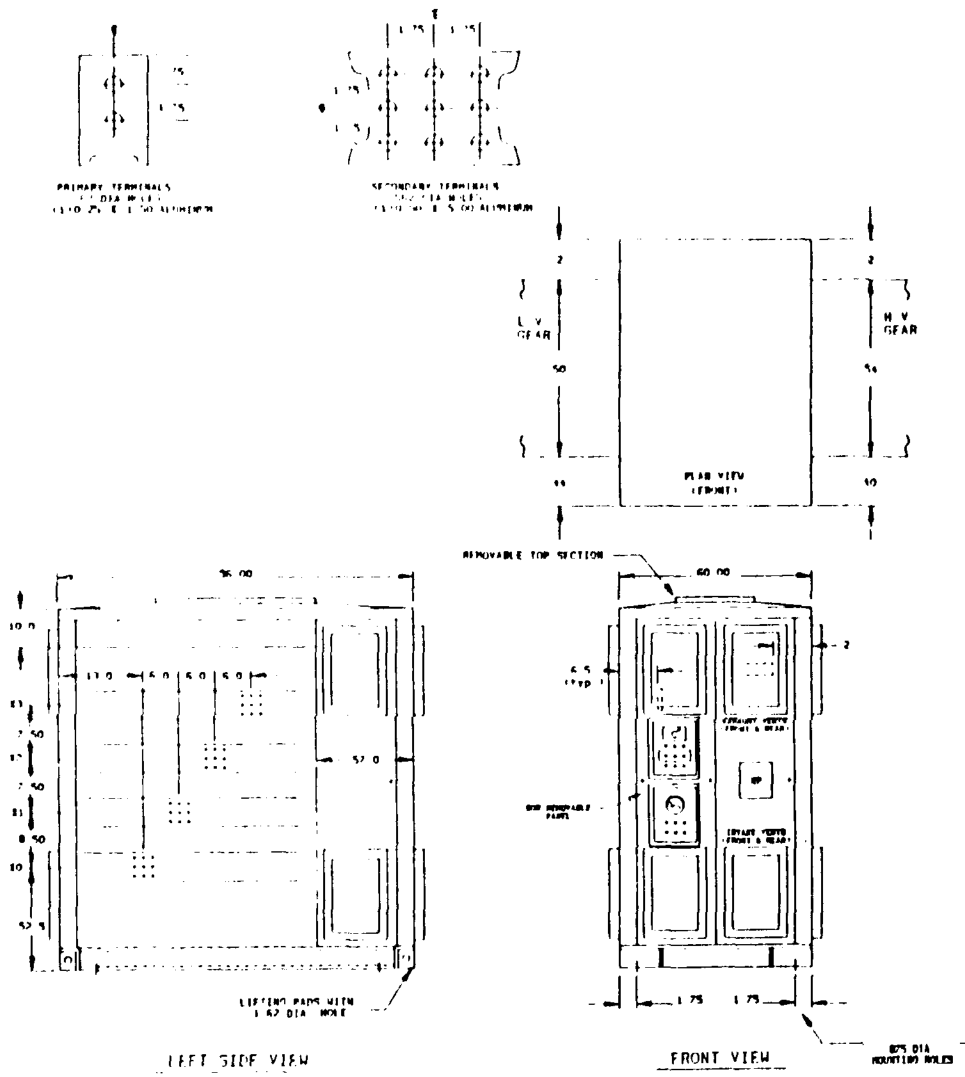
JOB NAME AND ADDRESS: SAN DIEGO NAVAL FACILITY

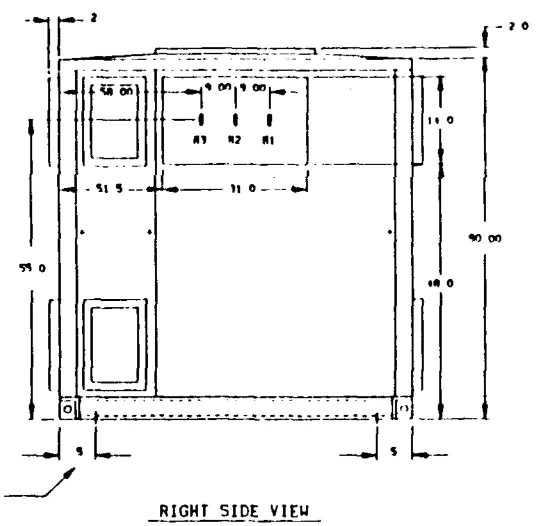
ALL DIMENSIONS ARE IN INCHES | SCALE: NOT TO SCALE

INSTALLED BY | ORDER NO | SOLD TO: ABB SERVICE CO | ORDER NO: LB 01446 C

ERA NATIONAL INDUSTRI TRANSFORMERS, INC. HAMPTON, VIRGINIA

DRAWN: WHITE | DATE: AUG 03 90 | DWG NO: C84 150CB109 10.1 | 2
CHECKED: STM | DATE: AUG 10 90 | S.O. NO: 02901 | REV





FEATURES

1 BREAKDOWN ENCLOSURE, 12 GA AND 14 GA CONSTRUCTION
2 STRUCTURAL STEEL BASE WITH PROVISIONS FOR LIFTING, JACKING AND SKIDDING
3 DARK FOREST GREEN PAINT FED STD 595a 61408 WITH PRIMER PROVIDED ON EXTERIOR AND INTERIOR FINISH
4 TWO NEMA 2 HOLE, STAINLESS STEEL GROUND PADS PROVIDED ON BASE
5 CORE AND COIL ASSEMBLY MOUNTED ON VIBRATION PADS AND GROUNDED TO ENCLOSURE BASE WITH (1) 4 0 CABLE
6 PROVISIONS FOR LIFTING OF CORE AND COIL ASSEMBLY (REMOVAL OF TOP ACCESS COVER REQUIRED)
7 ALUMINUM WOUND COILS, VACUUM CAST PRIMARY AND SECONDARY
8 ALL BOLTED BUS CONNECTIONS ARE CLEANED AND GREASED
9 TAPS, ON FACE OF COILS, ARE ACCESSIBLE BY REMOVAL OF FRONT BOLT ON PANELS
10 EXCEPT AS NOTED ALL FRONT AND REAR PANELS ARE REMOVABLE. QUANTITY MAY VARY FROM THAT SHOWN
11 SINGLE PHASE ANALOG FORCED AIR COOLING CONTROL, LESS FANS MOTORS AND CPT. THREE PHASE TEMPERATURE MONITORING PROVIDED
12 UNDERCOATING PROVIDED ON BASE

SPECIAL INSTRUCTIONS

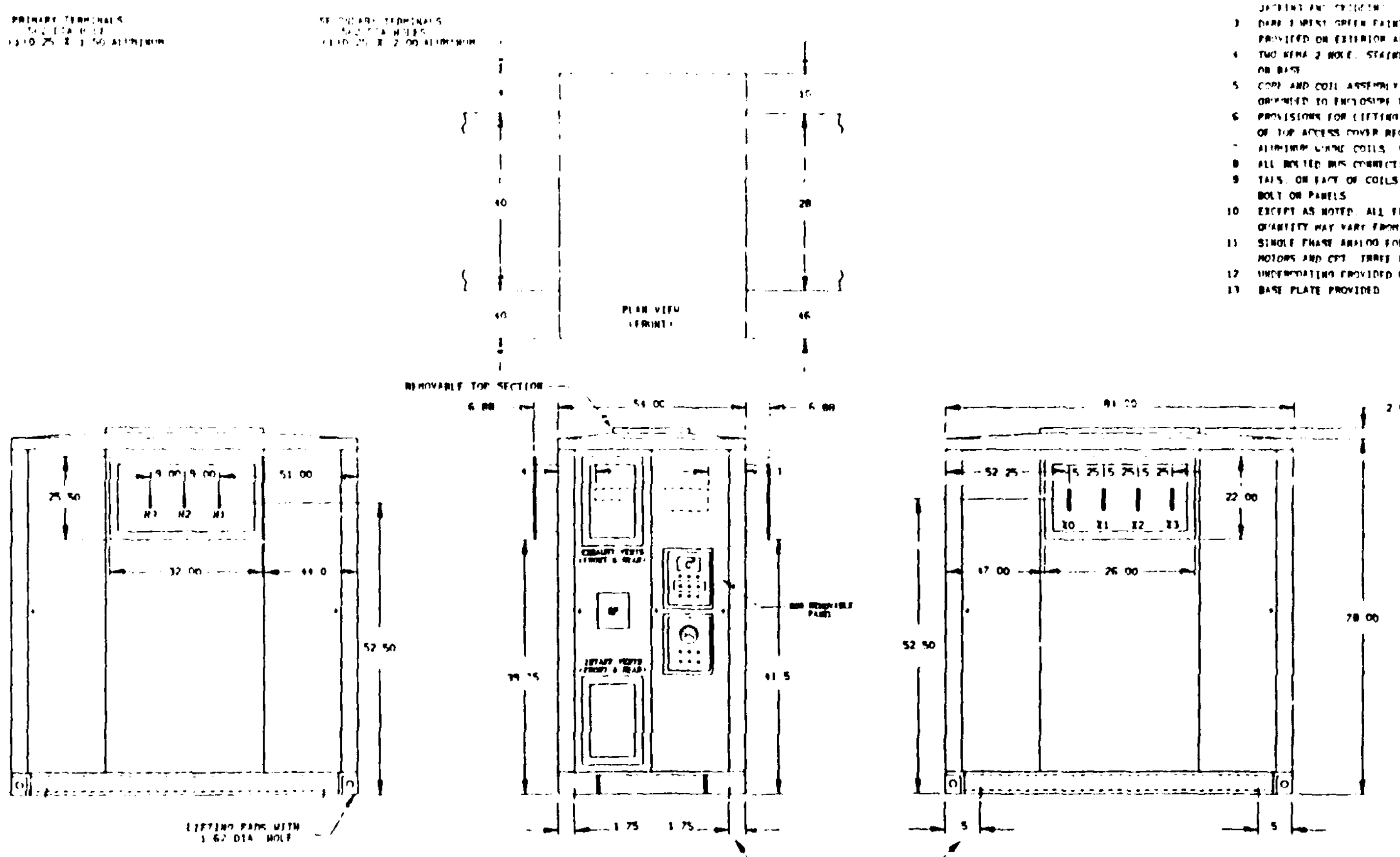
A REFER TO N I T I OPERATION AND MAINTENANCE MANUAL
B REMOVE ALL RED PAINTED STEEL PARTS BEFORE ENERGIZING UNIT

MARK UNIT ITEM 05 - BLDG 499-CC49

OUTDOOR, DRY, RETRO FIT TYPE, TRANSFORMER, AA/FA CLASS, QUANTITY 1, 15K V CLASS, 3 PHASE, 60 HZ, 185°C INSULATION, 25°C RISE, 95/30 K V BIL, 1500/2000 K V A, PRIMARY: 12000 DELTA, TAPS: (2) 2.5 %FCAN, (2) 2.5 %FCBN, SECONDARY: 480Y/277, 5.75 % ±7.5 % IMPEDANCE, APPROX WT 12900 LB

JOB NAME AND ADDRESS: SAN DIEGO NAVAL FACILITY			
ALL DIMENSIONS ARE IN INCHES		SCALE: NOT TO SCALE	
INSTALLED BY	ORDER NO	SOLD TO: ABB SERVICE CO	SHOP NO: LS 01446 C
EBA NATIONAL INDUSTRI TRANSFORMERS, INC HAMPTON, VIRGINIA	DRAWN: WHITE	DATE: AUG 10 90	DWG NO: C84-1500R110-10.1
	CHECKED: SEA	DATE: 8/15/90	S O NO: 02902 — REV

REV	DESCRIPTION	DATE



LEFT SIDE VIEW　FRONT VIEW　RIGHT SIDE VIEW

FEATURES

1. [illegible]
2. STRUCTURAL STEEL BASE WITH PROVISIONS FOR LIFTING, JACKING AND DRAGGING
3. DARK FOREST GREEN PAINT FED. STD. 595a [illegible] PRIMER PROVIDED ON EXTERIOR AND INTERIOR FINISH
4. TWO NEMA 2 HOLE, STAINLESS STEEL GROUND PADS PROVIDED ON BASE
5. CORE AND COIL ASSEMBLY MOUNTED ON VIBRATION PADS ARE GROUNDED TO ENCLOSURE BASE WITH [illegible] CABLE
6. PROVISIONS FOR LIFTING OF CORE AND COIL ASSEMBLY (REMOVAL OF TOP ACCESS COVER REQUIRED)
7. ALUMINUM WOUND COILS, VACUUM CAST PRIMARY AND SECONDARY
8. ALL BOLTED BUS CONNECTIONS ARE CLEANED AND GREASED
9. TAPS, ON FACE OF COILS, ARE ACCESSIBLE BY REMOVAL OF FRONT BOLT ON PANELS
10. EXCEPT AS NOTED, ALL FRONT AND REAR PANELS ARE REMOVABLE. QUANTITY MAY VARY FROM THAT SHOWN
11. SINGLE PHASE ANALOG FORCED AIR COOLING CONTROL, LESS FANS MOTORS AND CPT. THREE PHASE TEMPERATURE MONITORING PROVIDED
12. UNDERCOATING PROVIDED ON BASE
13. BASE PLATE PROVIDED

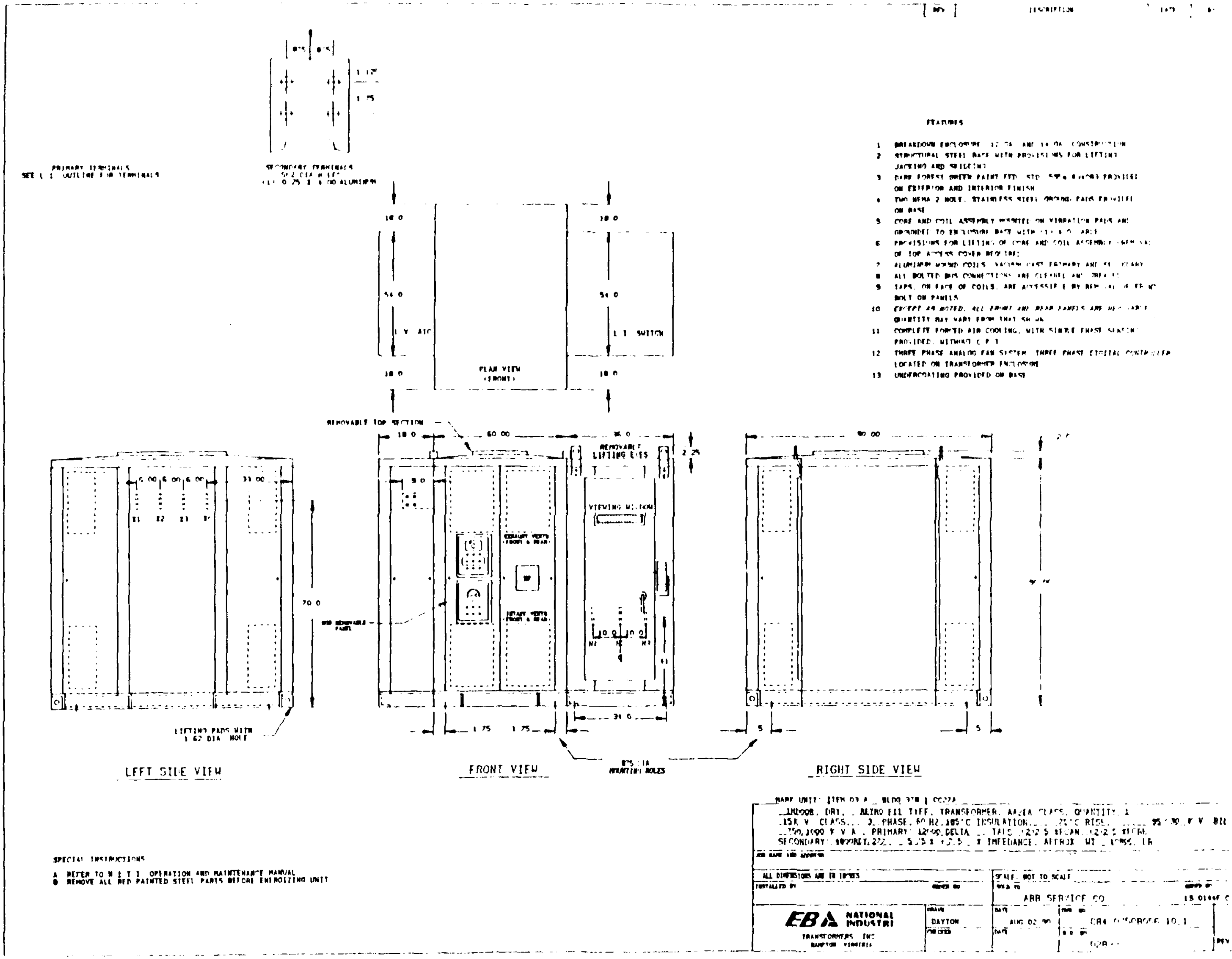
SPECIAL INSTRUCTIONS

A. REFER TO N.I.T.I. OPERATION AND MAINTENANCE MANUAL
B. REMOVE ALL RED PAINTED STEEL PARTS BEFORE ENERGIZING UNIT

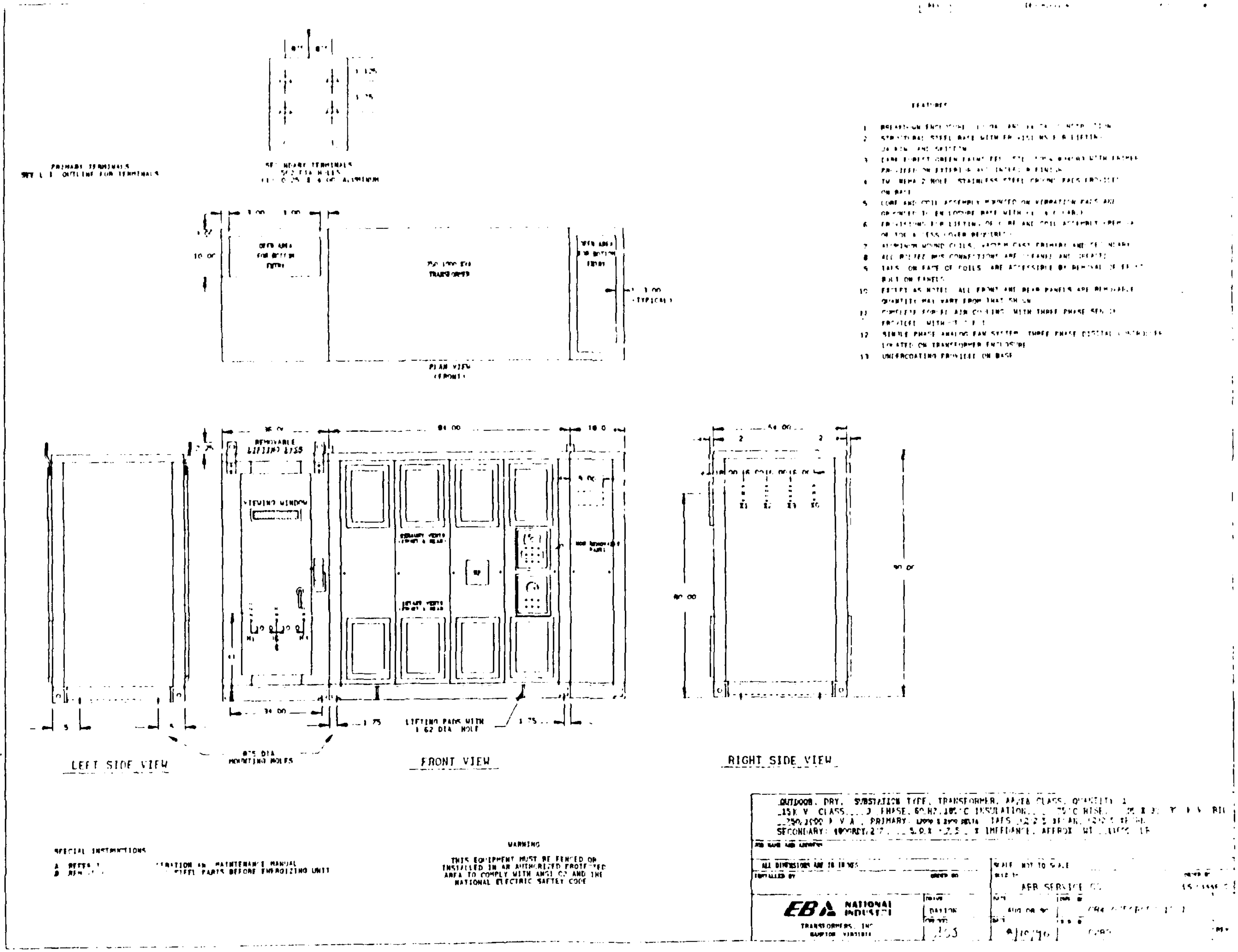
MARK UNIT ITEM 17 BLDG 328 & CC26

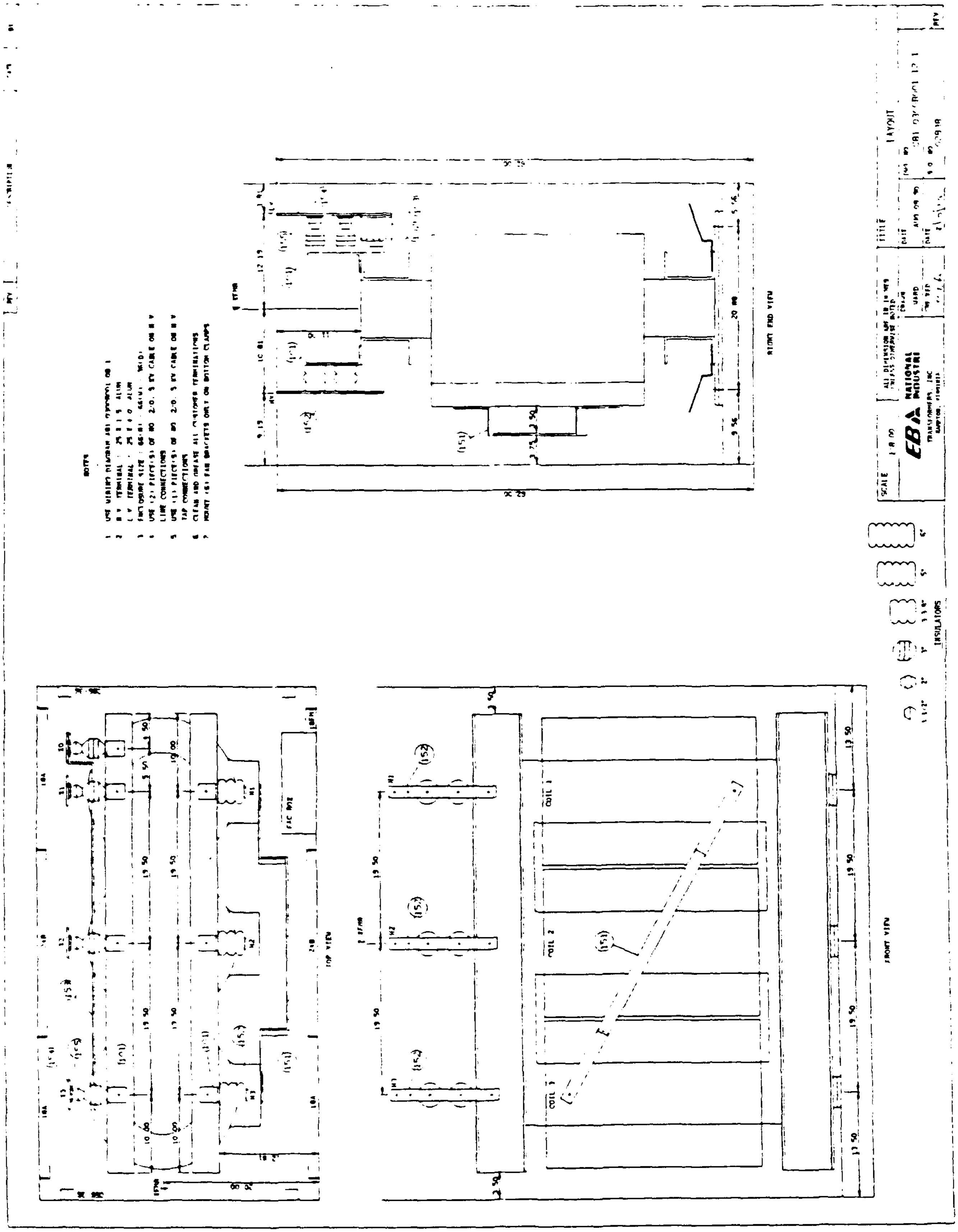
OUTDOOR, DRY, RETRO FIT TYPE, TRANSFORMER, AA/FA CLASS, QUANTITY 1
15 K V CLASS, 3 PHASE, 60 HZ, 185°C INSULATION, 75°C RISE, 95/30 K V BIL
500/667 K V A, PRIMARY: 12000 DELTA, TAPS: 2@2.5% FCAN, 2@2.5% FCBN
SECONDARY: 480 GRDY/277, 5.75 % ±2.5 % IMPEDANCE, APPROX WT 7000 LB

JOB NAME AND ADDRESS: SAN DIEGO NAVAL FACILITY			
ALL DIMENSIONS ARE IN INCHES		SCALE: NOT TO SCALE	
INSTALLED BY	ORDER NO	SOLD TO: ABB SERVICE CO	APPV BY: LS 01446 C
EBA NATIONAL INDUSTRI TRANSFORMERS, INC HAMPTON VIRGINIA	DRAWN: WHITE	DATE: AUG 15 90	DWG NO: CB4 0500R050 10.1
	CHECKED: SE	DATE: 8/16/90	S.O. NO: 02904	REV



FEATURES
1 BREAKDOWN ENCLOSURE
2 STRUCTURAL STEEL BASE WITH PROVISIONS FOR LIFTING JACKING AND SKIDDING
3 DARK FOREST GREEN PAINT ON EXTERIOR AND INTERIOR FINISH
4 TWO NEMA 2 HOLE, STAINLESS STEEL GROUND PADS PROVIDED ON BASE
5 CORE AND COIL ASSEMBLY MOUNTED ON VIBRATION PADS
6 PROVISIONS FOR LIFTING OF CORE AND COIL ASSEMBLY
7 ALUMINUM WOUND COILS
8 ALL BOLTED BUS CONNECTIONS ARE CLEANED AND
9 TAPS, ON FACE OF COILS, ARE ACCESSIBLE BY BOLT ON PANELS
10 EXCEPT AS NOTED, ALL FRONT AND REAR PANELS ARE QUANTITY MAY VARY FROM THAT SHOWN
11 COMPLETE FORCED AIR COOLING, WITH SINGLE PHASE SENSING PROVIDED, WITHOUT
12 THREE PHASE ANALOG FAN SYSTEM. THREE PHASE DIGITAL CONTROLLER LOCATED ON TRANSFORMER ENCLOSURE
13 UNDERCOATING PROVIDED ON BASE
PRIMARY TERMINALS
SECONDARY TERMINALS
PLAN VIEW (FRONT)
L V AIC
L T SWITCH
18.0
54.0
REMOVABLE TOP SECTION
60.00
36.0
REMOVABLE LIFTING EYES
VIEWING WINDOW
EXHAUST VENTS (FRONT & REAR)
INTAKE VENTS (FRONT & REAR)
70.0
90.00
31.0
1.75
5
LIFTING PADS WITH 1.62 DIA. HOLE
LEFT SIDE VIEW
FRONT VIEW
RIGHT SIDE VIEW
MOUNTING HOLES
SPECIAL INSTRUCTIONS
A REFER TO O&M MANUAL OPERATION AND MAINTENANCE MANUAL
B REMOVE ALL RED PAINTED STEEL PARTS BEFORE ENERGIZING UNIT
MARK UNIT: ITEM 03 A BLDG 370 CC27A
INDOOR, DRY, TYPE, TRANSFORMER, AA/FA CLASS, QUANTITY 1
15 K V CLASS, 3 PHASE, 60 HZ, 185°C INSULATION, 75°C RISE, 95 K V BIL
750/1000 K V A, PRIMARY 12000 DELTA
SECONDARY 480Y/277
ALL DIMENSIONS ARE IN INCHES
SCALE NOT TO SCALE
INSTALLED BY
ABB SERVICE CO
EBA NATIONAL INDUSTRI
TRANSFORMERS INC
DAYTON
AUG 02 90


LEFT SIDE VIEW
FRONT VIEW
RIGHT SIDE VIEW
PLAN VIEW
VIEWING WINDOW
REMOVABLE LIFTING EYES
LIFTING PADS WITH 1.62 DIA. HOLE
MOUNTING HOLES
PRIMARY TERMINALS
WARNING
THIS EQUIPMENT MUST BE FENCED OR INSTALLED IN AN AUTHORIZED PROTECTED AREA TO COMPLY WITH ANSI C2 AND THE NATIONAL ELECTRIC SAFETY CODE
SPECIAL INSTRUCTIONS
NATIONAL INDUSTRI
TRANSFORMERS, INC
AFB SERVICE CO.



NOTES
TOP VIEW
FRONT VIEW
RIGHT END VIEW
COIL 1
COIL 2
COIL 3
FAC BOX
INSULATORS
SCALE
TITLE
LAYOUT
NATIONAL INDUSTRI
TRANSFORMERS, INC

Appendix C

Operating and Maintenance Manuals and Product Information

August, 1985

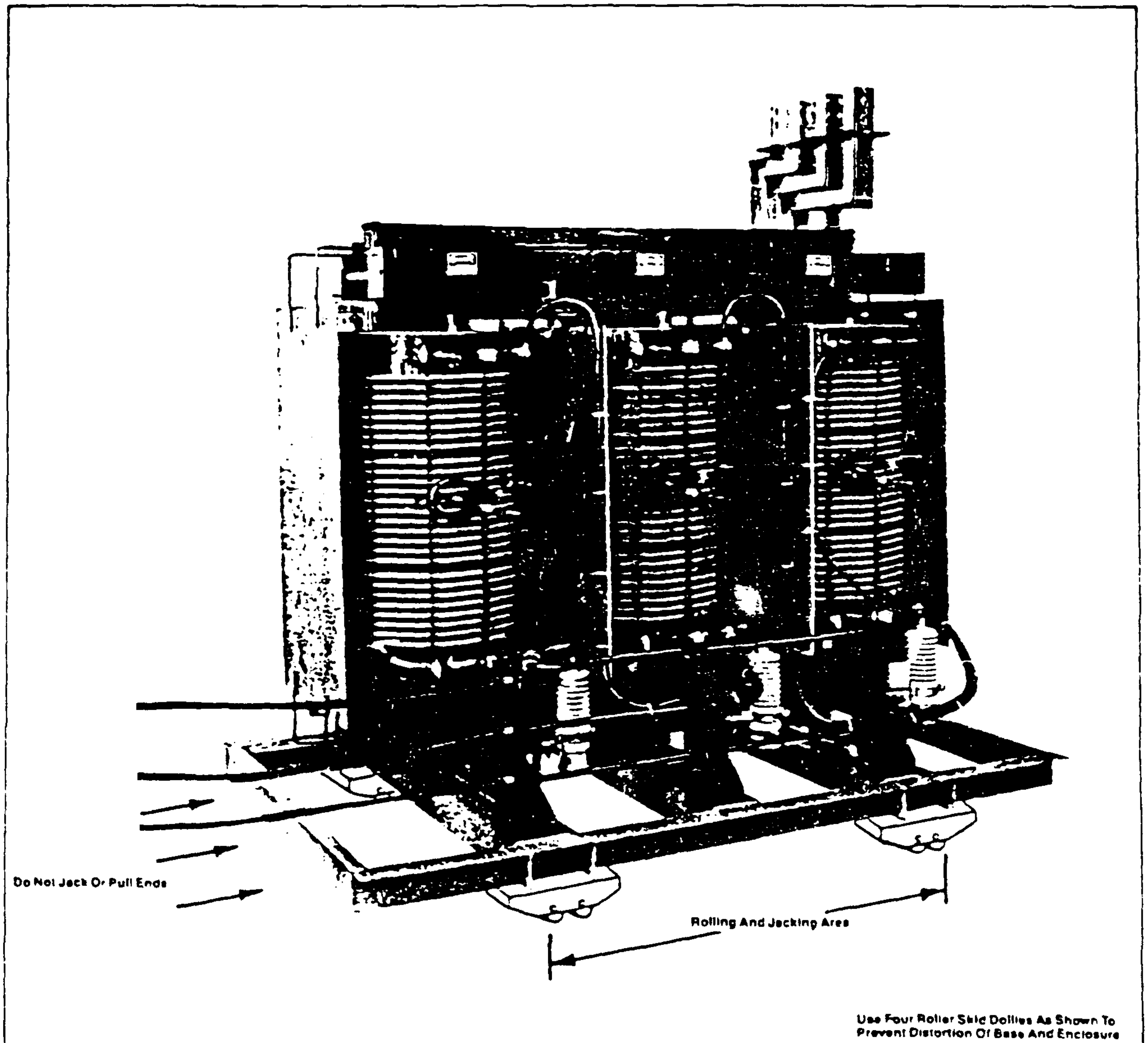
Supersedes Manual 7421-1 Dated 8/84

Manual 7421-1

(For Classes 7421 And 7422)

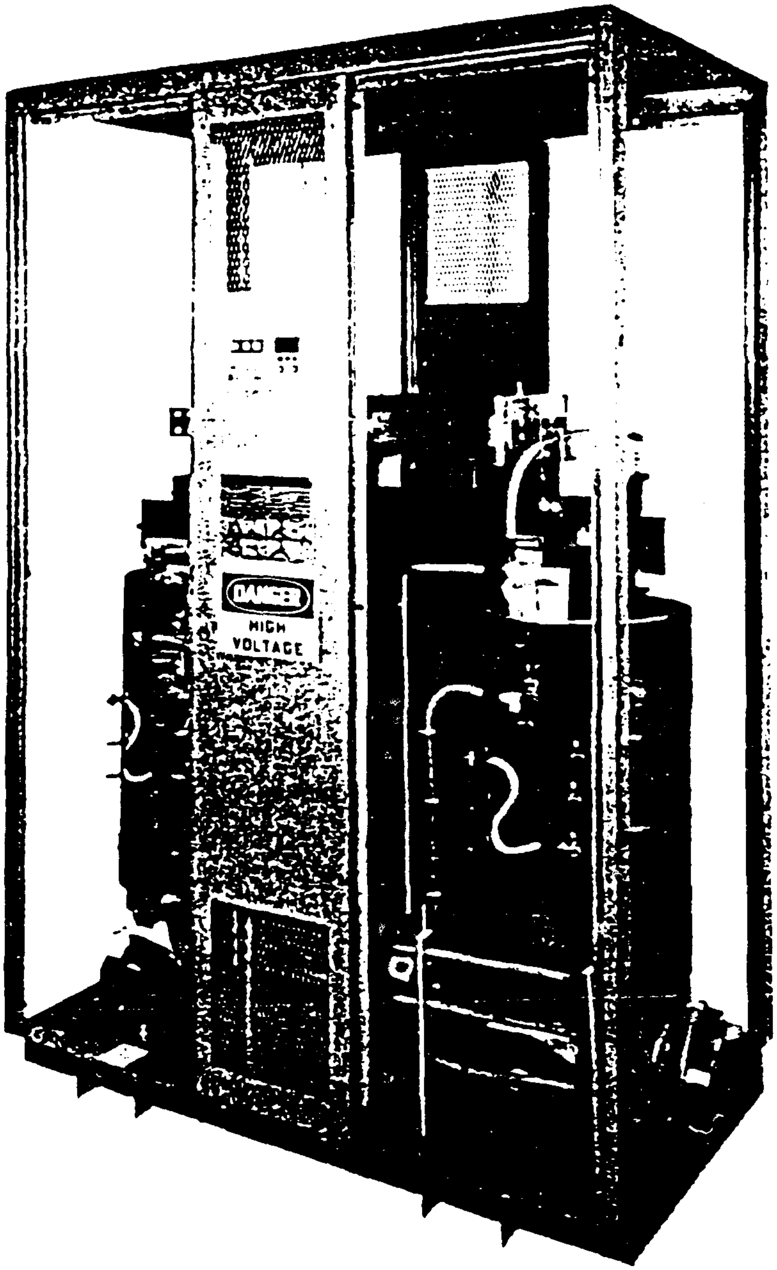
Instructions for Receiving, Installing Operating and Maintaining

DRY TYPE TRANSFORMERS



Use Four Roller Skid Dollies As Shown To Prevent Distortion Of Base And Enclosure

SQUARE D COMPANY



Dry Type Core And Coil Assembly, Compact Type, In 36" Deep, Ventilated Enclosure

Guide For The Operation And Maintenance Of Indoor Ventilated Dry Type Transformers

This instruction manual covers general recommendations for the operation and maintenance of dry type distribution and power transformers.

The successful operation of these transformers is dependent on proper installation, loading and maintenance as well as on proper design and manufacture. As with all electric apparatus, neglect of certain fundamental requirements may lead to serious trouble, if not to the loss of the equipment. For this reason, a wide distribution of information in regard to the care of dry type transformers is important, and these brief instructions are published for that purpose.

In addition to the use of this guide, the factory may be consulted for specific recommendations on special conditions. Also reference may be made to other publications, some of which are listed in the Appendix.

1. INSTALLATION

A. Location

Factors which should be kept clearly in mind in locating dry type transformers are accessibility, ventilation and atmospheric conditions.

Ventilated dry type transformers normally are designed for installation indoors in dry locations. They will operate successfully where the humidity is high but under this condition it may be necessary to take precautions to keep them dry if they are shut down for appreciable periods. This is discussed more fully under "Operation." Locations where there is dripping water should be avoided. If this is not possible, suitable protection should be provided to prevent water from entering the transformer case. Precautions should be taken to guard against accidental entrance of water, such as might occur from an open window, by a break in a water or steam line, or from use of water near the transformers. Adequate ventilation is essential for the proper cooling of transformers. Clean dry air is desirable. Filtered air may reduce maintenance if the location presents a particular problem. When transformers are installed in vaults or other restricted spaces, sufficient ventilation should be provided to hold the air temperature within established limits when measured near the transformer inlets. This usually will require a minimum of 100 cubic feet of air per minute per kilowatt of transformer loss. The area of ventilating openings required depends on the height of the vault, the location of openings, and the maximum loads to be carried by the transformers. For self-cooled transformers, the required effective area should be at least one square foot each of inlet and outlet per 100 KVA of rated transformer capacity, after deduction of the area occupied by screens, gratings or louvers.

Ventilated dry type transformers should be installed in locations free from unusual dust producing mediums or chemical fumes. Transformers should be located at least 12 inches from walls or other obstructions that might prevent free circulation of air through and around each unit. The distance between adjacent transformers should not be less than this value. Also, accessibility for maintenance should be taken into account in locating a transformer. If the transformer is to be located near combustible materials, the minimum separations established by the National Electrical Code should be maintained.

The transformer case is designed to prevent the entrance of most small animals and foreign objects. However, in some locations, it may be necessary to give consideration to additional protection.

In general, a flat, level industrial floor is adequate and no special preparation is necessary because of the base construction used on these transformers which completely eliminates the complicated process of grouting sills into concrete floors.

If noise is a factor in the location and operation of any transformers, special consideration should be given to the installation of the equipment.

The impulse strength of these transformers is less than that of liquid-immersed units of the same voltage class. If there is any likelihood that transformers will be exposed to lightning or severe switching surges, adequate protective equipment should be provided.

Transformers of standard temperature rise are designed to operate at altitudes up to and including 3300 feet. Dry type transformers are dependent upon air for dissipation of their heat losses and consequently the effect of decreased air density due to high altitude is to increase the temperature rise. Standard transformers can be used at altitudes greater than 3300 feet if the load to be carried is reduced below nameplate rating as follows:

1. If the transformer is dry type, self-cooled, Class AA, reduce the nameplate rating by 0.3% for each 330 feet that the altitude is above 3300 feet.

2. If the transformer is a dry type, forced air cooled, Class AA/FA, reduce the nameplate rating by 0.5% for each 330 feet that the altitude is above 3300 feet.

If the maximum 24 hour average temperature of the cooling air is reduced below design levels, the altitude limitation of 3300 feet can be safely exceeded without reducing the nameplate rating of the transformer within the limitations of the table below.

Maximum 24-hour Average Temperature of Cooling Air, Degrees C

Type of Apparatus	Altitude			
	3300 Feet (1000 Meters)	6600 Feet (2000 Meters)	9900 Feet (3000 Meters)	13200 Feet (4000 Meters)
DRY-TYPE CLASS AA				
80°C rise	30	26	22	18
115°C rise	30	24	18	12
150°C rise	30	22	15	7
DRY-TYPE CLASS AA/FA				
80°C rise	30	22	14	6
115°C rise	30	18	7	−5
150°C rise	30	15	0	−15

B. Inspection

New transformers should be inspected when received for damage during shipment. Examination should be made before removing from cars or trucks and if any injury is evident or any indication of rough handling is visible, a claim should be filed with the carrier at once and the manufacturer should be notified.

Subsequently, covers or panels should be removed and an internal inspection made for injury or displacement of parts, loose or broken connections, cracked porcelain, dirt or foreign material and for the presence of free water or moisture. Corrective measures should be taken where necessary. Shipping braces should be removed if provided.

After a transformer is moved, or if it is stored before installation, this inspection should be repeated before placing the transformer in service.

After making all the necessary primary and secondary connections the equipment should be thoroughly inspected. Before placing in service, the operation of fans, motors, thermal relays and other auxiliary devices should be checked. *All bolted connections which may have loosened in shipment must be tightened before energizing.* See torque listing below.

Keps nuts must be tightened to the following torque:

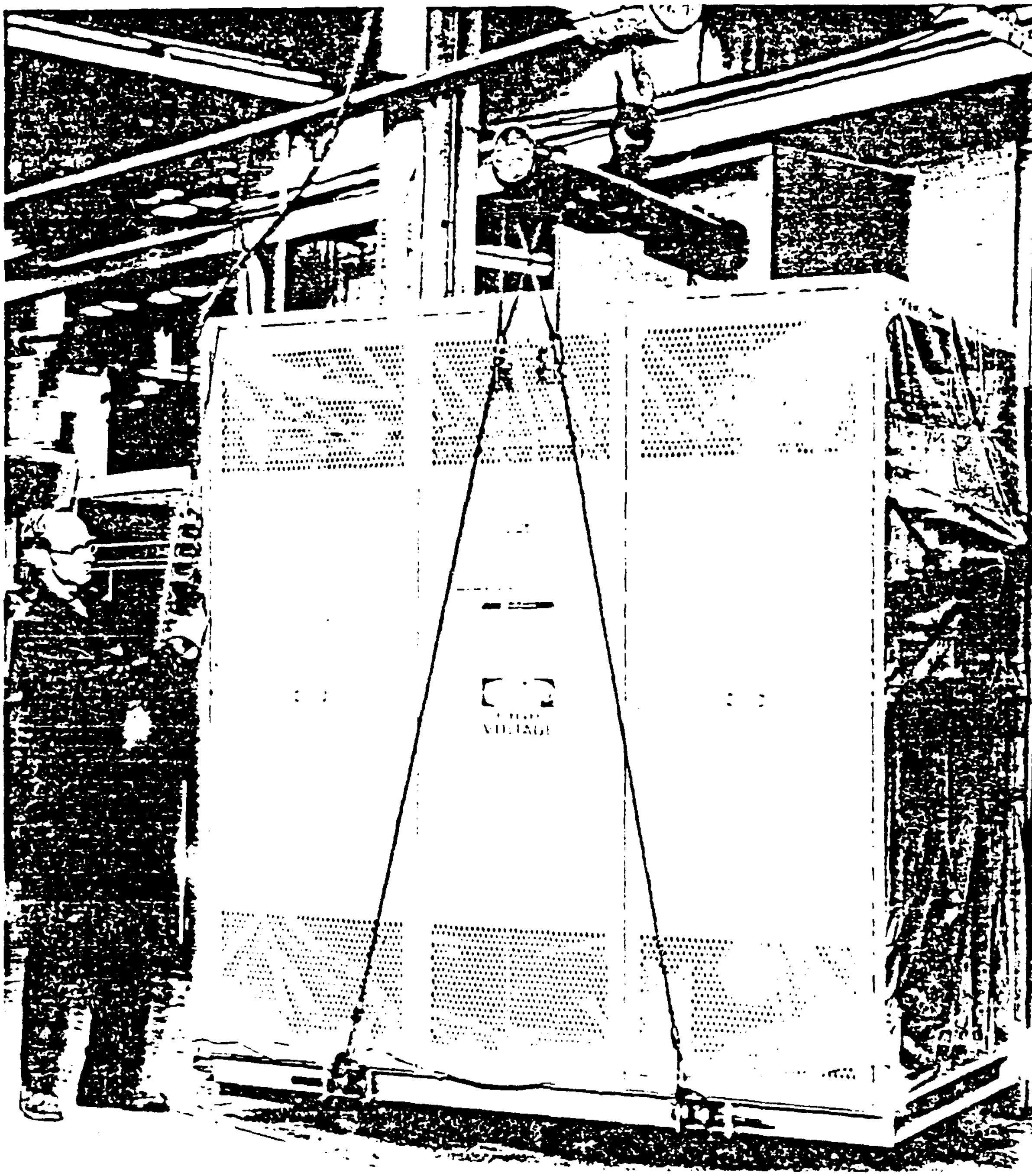
Size 1/4 – 20 torque 4-6 foot pounds
Size 5/16 – 18 torque 6-12 foot pounds
Size 3/8 – 16 torque 15-20 foot pounds
Size 1/2 – 13 torque 25-30 foot pounds

Do not over tighten.

C. Handling

Large dry type transformers are correctly handled as shown below. This method will prevent damage to the sheet metal enclosure using reasonable care. These transformers are constructed on a heavy, rigid base provided with integral lifting devices as seen in the photo. They must be lifted only from the base using proper cable spreaders to protect the enclosure. If they must be rolled or skidded, use four roller skid dollies, one near each integral lifting device, to prevent tipping and distortion of base and enclosure.

When ventilated transformers are handled or stored outdoors, they must be completely protected against any inclement weather to prevent entrance of rain or snow.



D. Grounding

The case and core assembly of these transformers should be permanently and adequately grounded.

2. TESTING

A. Insulation Resistance – Required

1. GENERAL

The insulation resistance test is of value for future comparative purposes and also for determining the suitability of the transformer for energizing or application of the high potential test. THE INSULATION RESISTANCE TEST MUST BE SUCCESSFULLY COMPLETED FOR FACTORY WARRANTY TO BE VALID. INSULATION RESISTANCE TEST MUST BE CONDUCTED IMMEDIATELY PRIOR TO ENERGIZING THE TRANSFORMER OR BEGINNING THE DIELECTRIC TEST.

All dry type unit substation transformers are given insulation resistance tests at the factory. These values are recorded on a large megger test tag, facsimile shown below, attached to the transformer.

IMPORTANT **READ CAREFULLY**

FOR TRANSFORMER WARRANTY TO BE VALID, THE FOLLOWING MEGGER TESTS MUST BE MADE, USING A MINIMUM OF A 1000 VOLT MEGGER, IMMEDIATELY PRIOR TO PLACING THIS TRANSFORMER IN SERVICE. BEFORE USING MEGGER BE SURE TO DISCONNECT LIGHTNING ARRESTERS, FAN SYSTEM, METERS, OR ANY LOW VOLTAGE CONTROL SYSTEM THAT IS CONNECTED TO ANY WINDINGS INVOLVED IN THIS TEST. THE TABULATIONS BELOW ARE VALUES OBTAINED ON THE FACTORY TEST FLOOR USING 1000 VOLT INSTRUMENT WITH A 2000 MEGOHM SCALE. IF VALUES OBTAINED IN THE FIELD TESTS ARE LESS THAN 1000 MEGOHM OR ONE-HALF THE FACTORY TEST VALUES LISTED BELOW WHICHEVER IS THE LESSER, THEN THE TRANSFORMER SHOULD NOT BE ENERGIZED UNTIL IT IS DRIED OUT AS DESCRIBED IN THE INSTRUCTION MANUAL FOR DRY TYPE TRANSFORMERS.

TRANSFORMER SERIAL NO.

DATE ______ TEMP. ° C______ LOW VOLTAGE TO GRD. ______ MEGS.

L.V. TO H.V.__________MEGS., H.V. TO GRD.__________MEGS. BY ________

43006-081-01

If the test tag is lost or destroyed, refer to the factory where a permanent record of these test results is kept on file.

The field insulation resistance test must be conducted immediately prior to energizing the transformer. These values, CORRECTED TO FACTORY TEST TEMPERATURE in degrees Centigrade, must be either 1,000 megohms or a minimum of one-half or more of the values obtained in the factory test when this value is less than 1,000 megohms. If the corrected field test values are less than the above minimum, the transformer is considered unsafe to energize and must be dried using procedure described under maintenance.

2. TEST PROCEDURE

a. If the transformer is not scheduled to be energized immediately, it is recommended that within one week after receiving, heat be placed under the transformer to insure dryness for megger test.

Six 150 watt lamps placed under the transformer; two lamps under each coil, one on each side of the core should be used for transformers rated 750 KVA and below. Use six 300 watt lamps for transformers rated 751 to 2000 KVA. Heat should be supplied on a continuous 24 hour per day basis. Ventilating openings should be blocked during this period.

b. Make sure transformer is clean using vacuum cleaner to insure removal of all foreign material that may affect insulation resistance test values.

c. Disconnect ALL high voltage, low voltage and neutral connections, as well as lightning arresters, fan system, meters or any low voltage control system that is connected to any windings involved in this test. Do not disconnect ground connection to transformer frame.

CAUTION

TEMPERATURE CONTROL SYSTEM (IF FURNISHED) MUST BE COMPLETELY DISCONNECTED DURING ANY TRANSFORMER TEST SUCH AS MEGGER, DIELECTRIC (HI-POT), DOBLE, ETC., TO PREVENT DESTRUCTION OF TEMPERATURE CONTROL CIRCUITRY.

d. Before beginning megger checks, jumper together all high voltage connections. Make sure jumpers are clear of all steel and grounded parts. Also jumper together all low voltage and neutral connections again making sure jumpers are clear of all steel and grounded parts.

e. Using a megger with a minimum scale of 2,000 megohms and minimum rating of 1,000 volts, make megger checks with the megger connected as follows (Note: Each megger check to be maintained for a period of one minute.)

(1) High voltage to ground
(2) Low voltage to ground
(3) High voltage to low voltage

f. Megger readings should be recorded along with test temperature (°C). If heat has been applied to transformer, determine temperature of transformer at time of test by placing thermometer on top of transformer core and allowing time for thermometer reading to stabilize. Using table on page 6, determine correction multiplier and multiply field test megger readings to obtain temperature corrected field test megger values.

g. If corrected field test megger values are less than one-half of factory test readings, the transformer is not considered safe for energizing or performing dielectric tests. Transformer should be dried as outlined under maintenance section.

h. If the corrected field test values are one-half or more of the factory readings or 1,000 megohms, whichever is less, the transformer is considered safe for conducting the dielectric test or energizing. Transformer connections should be remade and transformer energized immediately after completing insulation resistance test if dielectric test is not to be completed.

B. Dielectric Test — Recommended

1. GENERAL

The dielectric test imposes a stress on the insulation since the dielectric test voltage is higher than the normal operating voltage. The insulation resistance test must be successfully completed immediately before performing the dielectric test to prevent the possibility of transformer failure due to moisture. The dielectric test supplements the megger tests by determining the suitability of the transformer for operation at rated voltage.

Field test voltages should not exceed 75% of factory test values. For routine periodic checks test voltage should be 65% of factory test voltage. The high potential test set must be variable to allow a gradual increase of test voltage from zero and gradual decrease after test is completed

FIELD TEST TEMPERATURE - °C

FACTORY TEST TEMPERATURE °C / FACTORY TEST TEMPERATURE °F

°C	17.8	15	12.2	9.44	6.67	3.89	1.11	1.67	4.44	7.22	10.0	12.8	15.6	18.3	21.1	23.9	26.7	29.4	32.2	35.0	37.8	
15.6	0.10	0.12	0.15	0.18	0.21	0.26	0.31	0.38	0.46	0.56	0.68	0.82	1.00	1.22	1.47	1.78	2.17	2.63	3.22	3.84	4.76	60
16.7	0.09	0.11	0.13	0.16	0.20	0.24	0.29	0.35	0.43	0.52	0.63	0.76	0.93	1.12	1.36	1.65	2.00	2.42	2.94	3.56	4.31	62
17.8	0.085	0.10	0.12	0.15	0.18	0.21	0.27	0.33	0.40	0.48	0.58	0.71	0.86	0.99	1.26	1.51	1.85	2.24	2.72	3.10	4.00	64
18.9	0.08	0.09	0.11	0.14	0.17	0.20	0.25	0.30	0.37	0.45	0.54	0.65	0.79	0.96	1.17	1.41	1.71	2.15	2.52	3.06	3.71	66
20.0	0.07	0.09	0.11	0.13	0.16	0.19	0.23	0.28	0.34	0.41	0.50	0.61	0.73	0.89	1.08	1.11	1.59	1.97	2.13	2.82	3.44	68
21.1			0.10	0.12	0.15	0.18	0.21	0.26	0.31	0.38	0.46	0.56	0.68	0.82	1.00	1.22	1.47	1.78	2.17	2.63	3.22	70
22.2			0.09	0.11	0.13	0.16	0.20	0.24	0.29	0.35	0.43	0.52	0.63	0.76	0.93	1.12	1.36	1.65	2.00	2.32	2.94	72
23.3			0.085	0.10	0.12	0.15	0.18	0.21	0.27	0.33	0.40	0.48	0.58	0.71	0.86	0.99	1.26	1.51	1.85	2.24	2.72	74
24.4			0.08	0.09	0.11	0.11	0.17	0.20	0.25	0.30	0.37	0.45	0.54	0.65	0.79	0.96	1.17	1.41	1.71	2.15	2.52	76
25.6			0.07	0.09	0.11	0.13	0.16	0.19	0.23	0.28	0.34	0.41	0.50	0.61	0.73	0.89	1.08	1.31	1.59	1.92	2.13	78
26.7					0.10	0.12	0.15	0.18	0.21	0.26	0.31	0.38	0.46	0.56	0.68	0.82	1.00	1.22	1.41	1.78	2.17	80
27.8					0.09	0.11	0.13	0.16	0.20	0.23	0.29	0.35	0.43	0.52	0.61	0.76	0.91	1.12	1.36	1.65	2.00	82
28.9					0.085	0.10	0.12	0.15	0.18	0.21	0.27	0.33	0.40	0.48	0.58	0.71	0.86	0.99	1.26	1.53	1.85	84
30.0					0.08	0.09	0.11	0.14	0.17	0.20	0.25	0.30	0.37	0.45	0.54	0.65	0.73	0.96	1.17	1.41	1.71	86
31.1					0.07	0.09	0.11	0.13	0.16	0.19	0.23	0.28	0.34	0.41	0.50	0.61	0.73	0.89	1.08	1.31	1.59	88
32.2							0.10	0.12	0.15	0.18	0.21	0.26	0.31	0.38	0.46	0.56	0.68	0.87	1.00	1.22	1.47	90
33.3							0.09	0.11	0.13	0.16	0.20	0.24	0.29	0.35	0.43	0.52	0.63	0.76	0.93	1.12	1.36	92
34.4							0.085	0.10	0.12	0.15	0.18	0.21	0.27	0.33	0.40	0.48	0.58	0.71	0.86	0.99	1.26	94
35.6							0.08	0.09	0.11	0.14	0.17	0.20	0.25	0.30	0.37	0.45	0.54	0.65	0.79	0.96	1.17	96
36.7							0.07	0.09	0.11	0.11	0.16	0.19	0.23	0.28	0.34	0.41	0.50	0.61	0.73	0.89	1.08	98
37.8									0.10	0.12	0.15	0.18	0.21	0.26	0.31	0.38	0.46	0.56	0.68	0.82	1.00	100
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	°F

FIELD TEST TEMPERATURE - °F

Field Megger Test Values Correction Multiplier

(Note: For multipliers not shown transformer must be heated prior to making megger tests)

Following is a table showing factory dielectric test voltages with recommended field and periodic test voltages relative to the rated voltage of the respective windings.

Transformer Winding Rated A.C. Voltage	Factory Test A.C. Voltage	Recommended Field Test A.C. Voltage (75%)	Recommended Periodic Test A.C. Voltage (65%)
1.2 KV & below	4 KV	3.0 KV	2.6 KV
2.4 KV	10 KV	7.5 KV	6.5 KV
4.16 KV	12 KV	9.0 KV	7.8 KV
4.8 KV	12 KV	9.0 KV	7.8 KV
6.9 KV	19 KV	14.25 KV	12.35 KV
7.2 KV	19 KV	14.25 KV	12.35 KV
8.32 KV	19 KV	14.25 KV	12.35 KV
12.0 KV	31 KV	23.25 KV	20.15 KV
12.47 KV	31 KV	23.25 KV	20.15 KV
13.2 KV	31 KV	23.25 KV	20.15 KV
13.8 KV	31 KV	23.25 KV	20.15 KV

Under some conditions, transformers may be subjected to a periodic insulation test using direct voltage from kenotron sets. In such cases, the test direct voltage should not exceed the original factory test rms alternating voltage; e.g., if the factory test was 31 kilovolts root mean square (kV rms), then the routine test direct voltage should not exceed 31kV.

2. TEST PROCEDURE

a. Transformer must successfully pass the Insulation Resistance test *immediately* prior to starting dielectric tests.

b. Recheck items c, d and e of insulation resistance test to make sure transformer remains completely isolated and jumpers are still connected.

c. Jumper low voltage windings to ground.

d. Connect high potential test between high voltage winding and ground. Gradually increase test voltage to desired value. Allow test voltage duration of one minute after which gradually decrease voltage to zero.

e. Remove low voltage to ground jumper and connect high potential test between low voltage winding and ground. Repeat test using proper test voltage for low voltage winding rated voltage.

f. If tests in items d and e do not produce failure or breakdowns, transformer is considered satisfactory and ready to be energized.

g. Remove all jumpers and reconnect primary and secondary connections, lightning arresters, control circuits, etc., that may have been disconnected for test. Energize transformer immediately.

3. STORAGE

Ventilated dry-type transformers preferably should be stored in a warm dry location with uniform temperature. Ventilating openings should be covered to keep out dust. If it is necessary to leave a transformer outdoors it should be thoroughly protected to prevent moisture and foreign material from entering. Condensation and the absorption of moisture can be prevented or greatly reduced by the immediate installation of space heaters or other small electric heaters. If more convenient, incandescent lamps may be substituted for the space heaters. For transformer ratings 750 KVA three phase and below, use six 150 watt lamps, above 750 KVA three phase, use six 300 watt lamps or equivalent. Two lamps should be located under each coil, one on each side of the core. Lamps or heaters should be kept 4 - 6 inches from transformer coils and should never be allowed to come in contact with transformer coil insulation.

4. MAINTENANCE

A. Periodic Inspection and Maintenance

Like other electric equipment, these transformers require maintenance from time to time to assure successful operation. Inspection should be made at regular intervals and corrective measures taken when necessary to assure the most satisfactory service from this equipment.

The frequency at which these transformers should be inspected depends on operating conditions. For clean dry locations an inspection annually, or after a longer period, may be sufficient. However, for other locations, such as may be encountered where the air is contaminated with dust or chemical fumes, an inspection at three or six month intervals may be required. Usually after the first few inspection periods a definite schedule can be set up based on the existing conditions.

With the transformer de-energized, front and rear access panels should be removed. Inspections should be made for dirt, especially accumulations on insulating surfaces or for those which tend to restrict air flow, for loose connections, for the condition of tap changers or terminal boards and for the general condition of the transformer. Observation should be made for signs of overheating and of voltage creepage over insulating surfaces as evidenced by tracking or carbonization.

Evidence of rusting, corrosion and deterioration of the paint should be checked, and corrective measures taken where necessary.

Fans, motors and other auxiliary devices should be inspected and serviced during these inspection periods.

B. Cleaning

If excessive accumulations of dirt are found on the transformer windings or insulators when the transformer is inspected, the dirt should be removed to permit free circulation of air and to guard against the possibility of insulation breakdowns. Particular attention should be given to cleaning top and bottom ends of winding assemblies, and to cleaning out ventilating ducts.

The windings may be cleaned with a vacuum cleaner, a blower, or with compressed air. The use of a vacuum cleaner is preferred as the first step in cleaning followed by the use of compressed air or nitrogen. The compressed air or nitrogen should be clean and dry and should be applied at a relatively low pressure (not over 25 psi). Lead supports, tap changers and terminal boards, bushings and other major insulating surfaces should be brushed or wiped with a dry cloth. The use of liquid cleaners is undesirable because some of them have a solvent or deteriorating effect on most insulating materials.

C. Drying of Core and Coil Assembly

When it is necessary to dry out a transformer before installation or after an extended shutdown under relatively high humidity conditions, one of the following methods may be used:

1) External heat
2) Internal heat
3) External and internal heat

Before applying any of these methods, free moisture should be blown or wiped off of the windings to reduce the time of the drying period.

1) Drying by External Heat – External heat may be applied to the transformer by one of the following methods:

a. By directing heated air into the bottom air inlets of the transformer case.

b. By placing the core and coil assembly in a nonflammable box with openings at the top and bottom through which heated air can be circulated.

c. By placing the core and coil assembly in a suitably ventilated oven.

d. By placing incandescent lamps in transformer enclosure. See storage section for details.

It is important that most of the heated air be blown through the winding ducts and not around the sides. Good ventilation is essential in order that condensation will not take place in the transformer itself or inside the case. A sufficient quantity of air should be used to assure approximately equal inlet and outlet temperatures.

When using either of the first two external heating methods, heat may be obtained by the use of resistance grids or space heaters. These may either be located inside the case or box or may be placed outside and the heat blown into the bottom of the case or box. The core and coil assembly should be carefully protected against direct radiation from the heaters.

It is recommended that the air temperature should not exceed 110 °C.

2) Drying by Internal Heat – This method requires voltages and currents which may be difficult to obtain in the field and therefore is not used as frequently as external

The transformer should be located to allow free circulation of air through the coils from the bottom to the top of the case. One winding should be short-circuited, and sufficient voltage at normal frequency should be applied to the other winding to circulate approximately normal current.

It is recommended that the winding temperature not be allowed to exceed 100°C as measured by resistance or by thermometers placed in the ducts between the windings. The thermometers used should be of the spirit type because mercury thermometers give erroneous readings due to the generation of heat in the mercury as a result of induced eddy currents. The end terminals of the windings (and not the taps) must be used in order to circulate current through the entire winding. Proper precaution should be taken to protect the operator from dangerous voltages.

3) Drying by External and Internal Heat – This is a combination of the two methods previously described, and is by far the quickest method. The transformer core and coil assembly should be placed in a nonflammable box, or kept in its own case if suitable, and external heat applied as described in the first method, and current circulated through the windings as described in the second method. The current required will be considerably less than when no external heating is used but should be sufficient to produce the desired temperature of the windings. It is recommended that the temperatures attained not exceed those stated in the foregoing.

D. Use of Insulation Resistance for Determining Drying Time

Drying time depends on the condition of the transformer, size, voltage, amount of moisture absorbed, and the method of drying used.

The measurement of insulation resistance is of value in determining the status of drying. Measurements should be taken before starting the drying process and at two-hour intervals during drying. The initial value, if taken at ordinary temperatures, may be high even though the insulation may not be dry. Because insulation resistance varies inversely with temperature, the transformer temperature should be kept approximately constant during the drying period to obtain comparative readings. As the transformer is heated, the presence of moisture will be evident by the rapid drop in resistance measurement. Following this period the insulation resistance will generally increase gradually until near the end of the drying period when it will increase more rapidly. Sometimes it will rise and fall through a short range before steadying because moisture in the interior of the insulation is working out through the initially dried portions. A curve with time as abscissa and resistance as ordinate should be plotted and the run should be continued until the resistance levels off and remains relatively constant for three to four hours.

Insulation resistance measurements should be taken for each winding to ground with all windings grounded except the one being tested. Before taking insulation resistance measurements the current should be interrupted and the winding should be short-circuited and grounded for at least one minute to drain off any static charge. All readings should be for the same time of application of the test voltage, preferably one minute.

E. Cautions

Constant attendance during the drying process is desirable. It is advisable to have a suitable fire extinguisher convenient for use in the event of an emergency.

5. OPERATION

A. Removal of Covers over Openings

Covers over openings in the transformer case must not be removed while the transformer is energized.

B. Effect of Humidity

As long as the transformer is energized humidity conditions are relatively unimportant. In the event that a dry type transformer is de-energized and allowed to cool to ambient temperature, consideration must be given to the possible effects of humidity.

If the shutdown period occurs during low humidity conditions no special precautions should be required before energizing the unit.

Experience indicates that if a shutdown exceeding 24 hours occurs during a period of high humidity, particularly if atmospheric conditions are such as to cause condensation within the housing, then precautions should be taken. Small strip heaters may be placed in the bottom of the unit shortly after shutdown to maintain the temperature of the unit a few degrees above that of the outside air. If such precaution has not been taken then the unit should be inspected for evidence of moisture, and insulation resistance should be checked. If there is evidence of moisture or if the insulation resistance is low, the transformer should be dried out by one of the methods described.

C. Tap Changing

After installation, the output voltage of the transformer should be checked at some safe access point on the load. Never attempt to check the output voltage at the transformer since dangerous high voltage may be present within the transformer enclosure.

When the output or load side voltage requires adjustment either up or down, the percentage tap jumpers found on the front surface of the coils must be changed in all phases. (See photo on front cover of this bulletin for tap appearance.) Consult the transformer diagramatic nameplate for information on what tap must be used to correct for high or low incoming line voltage or for voltage drop in the output or load voltage due to long wiring runs. Note that when the load voltage is low, tap connections below 100% of line voltage must be used to raise the load voltage. If the load voltage is high, tap connections above 100% of line voltage must be used to lower the load voltage.

After the correct tap connection has been determined from the nameplate, this procedure should be followed to change taps:

1. De-energize transformer. Make sure there is no back feed from a low voltage tie breaker.
2. Remove front access panels from transformer enclosure.
3. Change tap jumper on each phase to the correct tap connection. Tap jumper must be on the same tap position on all phases.
4. Tap jumper must be installed on upper side of coil tap with lugs or ends of cable tap jumpers positioned for maximum electrical clearance from ground and other live parts. Be sure bolts are tightened.
5. Replace front access panels.
6. Energize transformer and recheck the output voltage.

APPENDIX

REFERENCES:

1. American Standard for Transformers, Regulators and Reactors, C57.12.01, C57.12.50, C57.12.51 and C57.12.91.
2. Dry-type Transformers for General Applications, NEMA Pub. No. ST20-1972.
3. Commercial, Institutional and Industrial Dry-type Transformers, NEMA Pub. No. TR27-1965.
4. National Electrical Code, NFPA No. 70, ANSI C1-1971.
5. National Electrical Safety Code, ANSI C2-1973.

BOLT TIGHTNESS FOR BUS CONNECTIONS
FOR HARDWARE SHIPPED WITH TRANSFORMER

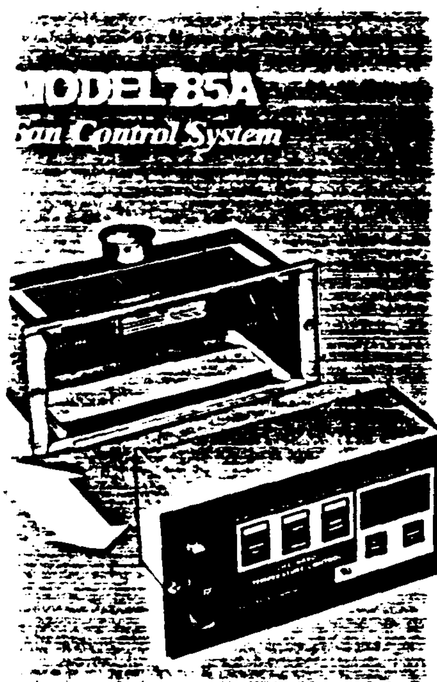
Bolt Material	Torque in Foot Pounds for Bolt Diameter			
	.25-20	.31-18	.38-16	.50-13
Grade 1 & 2 Heat Treated Steel	4-6	6-12	15-20	25-30

MODEL 85A

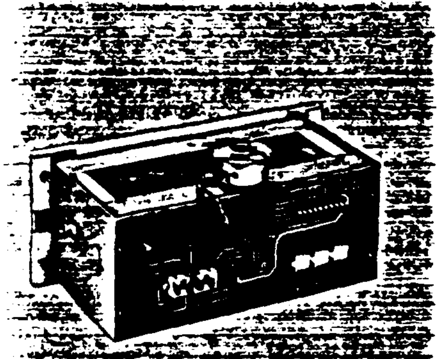
FAN CONTROL SYSTEM

Keeps Transformers
Running Cooler.
A[illegible]s 33⅓%
R[illegible]serve Capacity.

SQUARE D COMPAN
Dedicated to Growth • Committed to Qua



"Draw-out" design permits inspection of control unit without exposure to high voltages.



Easily discernible circuit board connection on rear of control housing.

The Square D Model 85A "LIFE-GARD™" Fan Control System is state-of-the-art instrumentation that protects the transformer and adds up to 33-1/3% reserve capacity.

This system provides precision control through the use of three high accuracy thermistor type temperature sensors, one installed in an air duct of each phase coil of a transformer.

Internal coil temperatures are transmitted by these sensors to a microprocessor which is programmed to provide a digital display of temperature in degrees Celsius and the corresponding coil number.

Digital Display

The digital LED display range is from 24°C to 255°C in 1°C increments. Characters are 0.56" high and clearly legible under all lighting conditions.

The Model 85A provides a choice of either:

A. Continuous scanning of the three sensors with a three second display period for each coil temperature and corresponding coil number.

B. Digital display of the temperature and number of the hottest coil only.

For each display mode, two additional options are available:

1. Continuous temperature display.
2. Display only when the "Read/Reset" or the "Read Memory Max" switch panels are pressed.

For all display modes, the highest temperature reached by any coil in any previous interval will be displayed for three seconds when the "Read Memory Max" switch panel is pressed. This temperature will be cancelled and replaced by the immediate maximum temperature when both "Read/Reset" and "Read Memory Max" switch panels are pressed simultaneously. Thereafter, any succeeding higher temperature will be retained in memory for later recall.

Control Mode Light Panels

Three LED panels are provided to indicate control mode conditions. When the green panel is lighted, it indicates that the control module is energized. Similarly, the lighted yellow panel indicates that the fan circuit is energized. A lighted red panel indicates that one or more coils are above normal temperature and the alarm horn will sound.

If a temperature of 220°C** is detected by one of the sensors, the control will initiate the emergency shutdown mode. Permanent insulation damage will occur above this maximum insulation system temperature. At this point, the Red LED panel flashes and three dashes replace the temperature numbers.

Actual shutdown or other function can be accomplished by means of an optional, accessory relay.

Reference: ANSI Standard C57.12.51

Rated Average Transformer Temperature Rise*	Switch Set Points: Fans On	Fans Off	Alarm On	Alarm Off	Emergency Shutdown	Emergency Shutdown Cast Resin Transformers
80°C	110°C	100°C	125°C	123°C	220°C	185°C
115°C	145°C	135°C	160°C	158°C	220°C	185°C
150°C	180°C	170°C	195°C	193°C	220°C	———

*Based on NEMA and ANSI Standards of 30°C average and 40°C maximum ambient for any 24 hour period below 3300 ft. altitude

NOTE: The digital temperature displayed is always the TOTAL temperature of AMBIENT + HOT SPOT temperatures, not the AVERAGE temperature rise. (Example: A transformer is rated 150°C average temperature rise when carrying rated full load in a 20°C ambient temperature. The thermistor sensors are installed near the theoretical hot spot of the coils. NEMA and ANSI standards permit a 30°C maximum differential between average and hot spot temperatures. Therefore the digital display would indicate approximately 20°C + 30°C + 150°C = 200°C total. Note that the alarm would operate at this point providing ample warning that the transformer is approaching the maximum temperature limit of the insulation system.)

Fan Mode Control and Indicators

Selection of two modes of fan operation is provided by the "Fan Mode" switch panel. When this switch panel is depressed, the fan mode may be changed from manual to auto or vice versa. In the auto mode, the fans are turned on and off automatically at specified programmed temperature set points. In the manual mode, the fans operate continuously, totally independent of all temperature set points. The selected fan mode is indicated by one of the LEDs in the "Fan Mode" switch panel.

High Temperature Alarm

If the operating temperature of the transformer coils increases to the programmed "alarm" set point, the red LED indicator and the alarm horn are activated, thus warning that the maximum designed temperature rise

**185°C for Cast Resin Transformers

TYPICAL INSTALLATIONS

has occurred (80°C, 115°C or 150°C). This temperature is within the maximum temperature rating of the insulation system, and the transformer may continue to operate. The alarm horn may be silenced by briefly depressing the "Alarm Silence" switch panel. The red LED panel, however, will remain lighted until the transformer temperature decreases to the programmed "Alarm Off" set point. The LED panel is then de-energized and the silencer relay is automatically reset.

Control Sequence

The Model 85A Fan Control System provides switching at three levels of transformer temperature. This switching is pre-set prior to shipment based on the maximum rating of the insulation system and the designed temperature rise of the transformer 150°C, 115°C or 80°C rise.

At the first switching level, cooling fans are automatically switched on and off at the temperature set points to maintain the winding temperature well within the design limits.

At the second level, the alarm set point temperature is reached and the alarm circuit is energized, operating a visual and audible alarm. This indicates that the transformer has reached a temperature that is not more than 5°C higher than the designed *average* winding temperature rise based on a 40°C maximum ambient.

If kept within the maximum temperature rating of the insulation system (220°C**), the transformer may continue to operate.

A third level operates when the maximum temperature rating (220°C**) of the insulation system is reached. This energizes the Emergency Shutdown (E.S.) circuit. This circuit can be used for a remote alarm or to automatically drop transformer load and prevent damage to the transformer insulation.

The Model 85A Fan Control System provides two sets of auxiliary Form "C" relay contacts; one set switched by the fan control circuit and one switched by the alarm control circuit. Terminals for these contacts are located on the rear panel of the control.

The output for the emergency shutdown function is 6V D.C. at 300 MA maximum to power an optional external relay. Terminals for this output are also located on the rear panel of the control.

System Test

The Model 85A Fan Control System also incorporates a programmed system test function which is initiated when the "System Test" switch panel is depressed. Each of the various indicators and each segment of the numerical displays are tested in sequence. The upper left segments of the coil and temperature displays are not active and are not lighted during the test sequence.

During the test sequence, the fans operate briefly. The alarm horn is also tested at the end of the sequence and the Emergency Shutdown is not activated.

Remote Indication and Control

In addition to providing control and readout functions when installed in a transformer, the Model 85A Fan Control System has the capability of providing complete readout and control at a remote location. One control module with temperature sensors is mounted in the transformer enclosure and is designated as the "Master". A second identical control without temperature probes is designated as the "Slave" for installation remote from the transformer. By means of an IEEE RS-422 two-wire communication link, the temperature may be monitored and all functions controlled at a remote location.

Similarly, an installation with multiple transformers may be monitored and controlled from a single supervisory station or by a computer.

**185°C for Cast Resin Transformers
Power Cast is a Registered Trademark of Square D Company

MODEL 85A

Fail-Safe Features

The Model 85A Fan Control System is capable of determining a shorted sensor condition. It will also detect a possible open sensor. When two probes read a temperature above 25°C and one reads a temperature of 25°C or less, the latter will be determined open. When either a shorted or open sensor is identified, the temperature display will indicate three dashes (instead of numerals) with the corresponding coil number.

For systems having a Slave Model 85A Fan Control System for remote control and monitoring, failure of the Master control at the transformer will cause all coil and temperature readouts of the remote control to be dashes and the alarm LED panel will flash every 20 seconds as the remote control attempts to reset to normal communication with the Master control.

Typical Specifications

Provide a Square D LIFE-GARD® Model 85A, solid state, Fan Control System with factory pre-set, three level switching to maintain the winding temperature within the design limits during fan-cooled operation. For three phase transformers, the system shall consist of three high-accuracy thermistor sensors installed directly in the low voltage air ducts of each transformer coil to continuously monitor the internal coil temperature. The sequence of operations shall be as follows: If the temperature rises to the normal, self-cooled (AA) rating, a relay is activated to start the fans. Should the temperature continue to rise to the next pre-set point, a second relay operates to close the circuit for an audible alarm and a red warning light. If the temperature rises to the maximum rated temperature of the insulation system, a third circuit is activated. It may be used for an emergency shutdown, or remote trouble indication.

The control module shall be a "draw-out" design permitting inspection of the control unit without exposure to high voltages.

The system control module shall have a membrane front panel with switches to provide system tests, fan mode selection and alarm silencing. Function indicators shall be LED bars; Green for "Power On", Amber for "Fans On" and Red for "High Temperature".

The "System Test" switch shall initiate a test sequence which will allow verification that all control functions and numeric read-out segments are operational.

The "Fan Mode" switch, with built-in LED mode indicators, shall provide selection of manual or automatic fan control modes.

The "Alarm Silence" switch shall silence the sonic alarm, but allow the Red LED bar to remain "On" until the temperature decreases to normal.

The system control module shall provide a digital read-out of transformer coil temperature and numeric coil identification.

The system control module shall have a memory mode for retention of the maximum attained temperature during any prior interval with recall to occur when the "Read Memory Max" switch is pressed.

Minimum numeral height shall be 0.5 inch.

The system control module shall be capable of functioning at the transformer (Master Control) or at a remote location (Slave Control), using an RS-422 communication link to provide full control and read-out at both locations.

The system control module shall provide Fail-Safe indication of both shorted and open sensors.

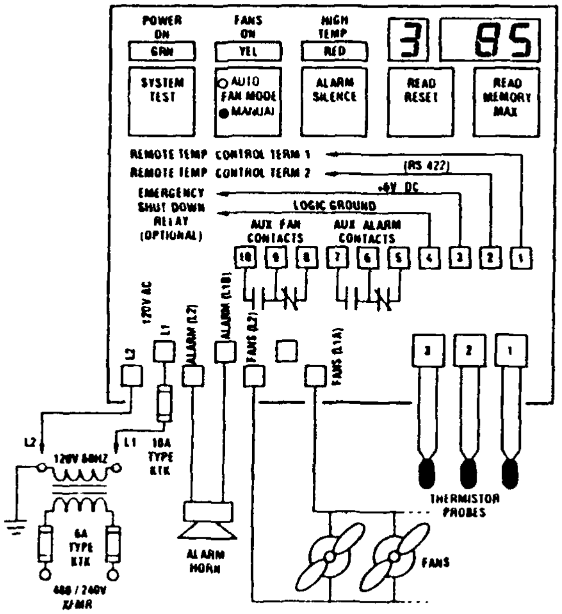
Multiple cooling fans are to be installed at the bottom of each coil, front and rear, with a minimum of six for three phase and four for single phase transformers.

NOTE: For voltages over 600 volts, a separate 120 volt AC source may be utilized. If none is available, a fused, high voltage transformer may be specified but this would require an additional compartment.

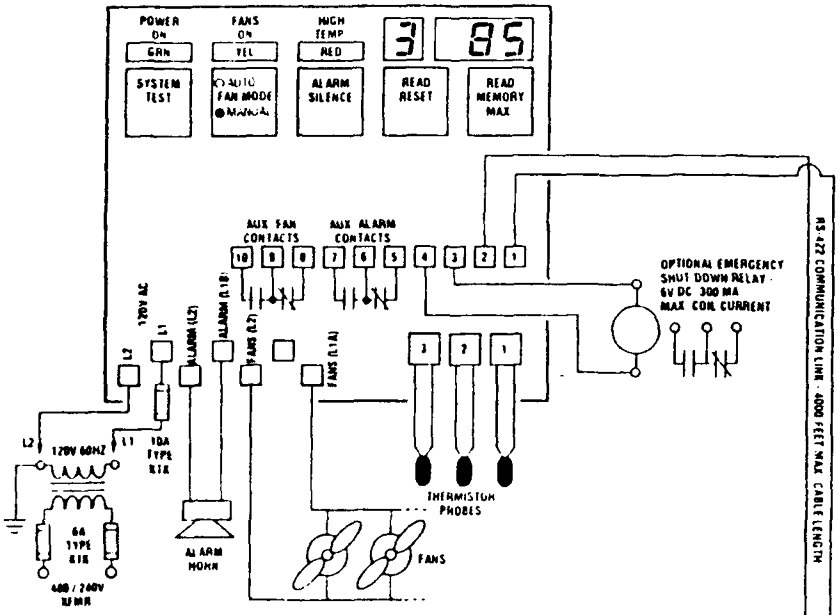
Wiring diagrams

Model 85A
Fan Control System

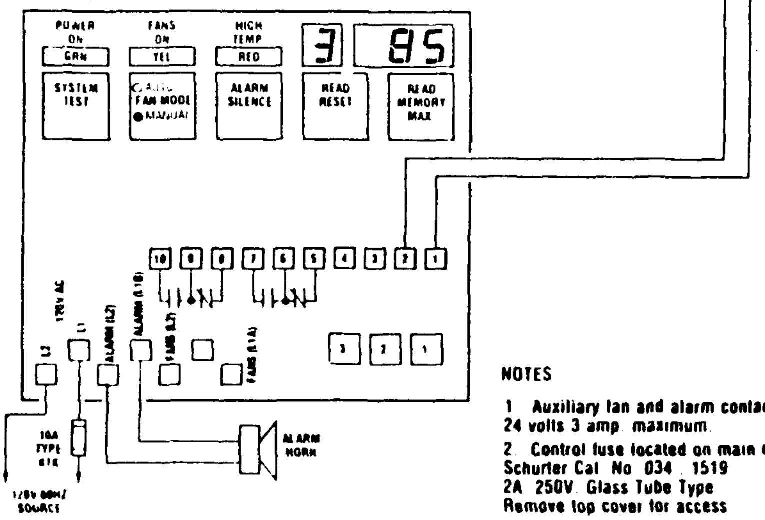
Model 85A Master Control



Master Control at Transformer



Remote Control



NOTES

1. Auxiliary fan and alarm contacts are rated 24 volts 3 amp. maximum.
2. Control fuse located on main circuit board. Schurter Cat. No. 034. 1519 2A 250V. Glass Tube Type Remove top cover for access

MODEL 85A
Fan Control System

SALES OFFICES IN THE UNITED STATES

ALABAMA	
Birmingham	(205) 870 5591
Dothan	(205) 793 2177
Huntsville	(205) 539 2465
Mobile	(205) 342 7747
Montgomery	(205) 271 0230
ALASKA	
Anchorage	(907) 278 6048
ARIZONA	
Phoenix	(602) 231 8694
Tucson	(602) 795 3600
ARKANSAS	
Ft. Smith	(501) 452 7312
Little Rock	(501) 225 3648
CALIFORNIA	
Bakersfield	(805) 833 1985
Fresno	(209) 268 6268
Hayward (San Francisco)	(415) 887 1181
Long Beach	(213) 428 7553
North Hollywood (Los Angeles)	(818) 508 0592
Orange	(714) 532 4861
Riverside	(714) 687 1262
Sacramento	(916) 381 5056
San Diego	(619) 569 8953
Stockton	(209) 944 5633
Ventura	(805) 658 2566
COLORADO	
Colorado Springs	(719) 531 5274
Englewood (Denver)	(303) 799 9003
CONNECTICUT	
Wethersfield (Hartford)	(203) 529 7472
DISTRICT OF COLUMBIA	
Rockville (Wash. D.C.)	(301) 424 9510
	(301) 424 1442
FLORIDA	
Altamonte Springs (Orlando)	(407) 774 5151
Ft. Myers	(813) 936 5573
Jacksonville	(904) 744 7861
Palm Beach Gardens (West Palm Beach)	(407) 626 8788
Pembroke Pines (Miami)	(305) 435 4400
Sarasota	(813) 957-0950
Tallahassee	(904) 878 7895
Tampa	(813) 289 0227
GEORGIA	
Columbus (Muscogee)	(404) 561 7825
Macon	(912) 745 2382
Savannah	(912) 356 9546
Smyrna (Atlanta)	(404) 333 3660
HAWAII	
Honolulu	(808) 422 0567
IDAHO	
Boise	(208) 376 0552

SQUARE D COMPANY
Dedicated to Growth • Committed to Quality
Transformer Division
P.O. Box 5002
Monroe, NC 28110-9954
(704) 283-7411
FAX: (704) 283-2807

MODEL 85A
Fan Control System

For more information, contact your local Square D Sales Office.

SALES OFFICES IN THE UNITED STATES

ALABAMA	
Birmingham	(205) 870 5591
Dothan	(205) 793 2177
Huntsville	(205) 539 2465
Mobile	(205) 342 7747
Montgomery	(205) 271 0230
ALASKA	
Anchorage	(907) 278 6048
ARIZONA	
Phoenix	(602) 231 8694
Tucson	(602) 795 3600
ARKANSAS	
Ft Smith	(501) 452 7312
Little Rock	(501) 225 3648
CALIFORNIA	
Bakersfield	(805) 833 1985
Fresno	(209) 268 6268
Hayward (San Francisco)	(415) 887 1181
Long Beach	(213) 428 7553
North Hollywood (Los Angeles)	(818) 508 0592
Orange	(714) 532 4861
Riverside	(714) 687 1262
Sacramento	(916) 381 5056
San Diego	(619) 569 8953
Stockton	(209) 944 5633
Ventura	(805) 658 2566
COLORADO	
Colorado Springs	(719) 531 5274
Englewood (Denver)	(303) 799 9003
CONNECTICUT	
Wethersfield (Hartford)	(203) 529 7472
DISTRICT OF COLUMBIA	
Rockville (Wash D C)	(301) 424 9510
	(301) 424 1442
FLORIDA	
Altamonte Springs (Orlando)	(407) 774 5151
Ft Myers	(813) 936 5573
Jacksonville	(904) 744 7881
Palm Beach Gardens (West Palm Beach)	(407) 626 8788
Pembroke Pines (Miami)	(305) 435 4400
Sarasota	(813) 957 0950
Tallahassee	(904) 878 7895
Tampa	(813) 289 0227
GEORGIA	
Columbus (Muscogee)	(404) 561 7825
Macon	(912) 745 2382
Savannah	(912) 356 9546
Smyrna (Atlanta)	(404) 333 3660
HAWAII	
Honolulu	(808) 422 0567
IDAHO	
Boise	(208) 376 0552
ILLINOIS	
Champaign	(217) 356 0211
Lombard (Chicago)	(312) 916 9550
Peoria	(309) 673 0508
Rockford	(815) 965 2060
Springfield (Sangamon)	(217) 546 1477
INDIANA	
Evansville	(812) 424 9999
Fort Wayne	(219) 483 3194
Highland (Hammond)	(219) 972 9600
	(312) 721 6031
Indianapolis	(317) 255 0664
Mishawaka (So Bend)	(219) 259 8521
IOWA	
Cedar Rapids	(319) 366 0736
Davenport	(319) 324 0876
Des Moines	(515) 224 9918
KANSAS	
Shawnee (Kansas City)	(913) 631 1000
Wichita	(316) 264 9338
KENTUCKY	
Lexington	(606) 278 0308
Louisville	(502) 425 8363
Paducah	(502) 554 5515
LOUISIANA	
Baton Rouge	(504) 926 7279
Harahan (New Orleans)	(504) 733 0964
Lafayette	(318) 988 1560
Shreveport	(318) 865 4267
MAINE	
Portland	(207) 774 1409
MARYLAND	
Hagerstown	(301) 739 5760
Salisbury	(301) 749 2544
Towson (Baltimore)	(301) 337 8448
MASSACHUSETTS	
Braintree (Boston)	(617) 848 1110
MICHIGAN	
Grand Blanc (Flint)	(313) 694 5101
Grand Rapids	(616) 459 3529
Kalamazoo	(616) 342 2117
Lansing	(517) 337 2835
Saginaw	(517) 792 1553
Traverse City	(616) 946 3773
Troy (Detroit)	(313) 680 4444
MINNESOTA	
Duluth	(218) 723 1010
Plymouth (Minneapolis)	(612) 476 6909
Rochester	(507) 285 1700
MISSISSIPPI	
Jackson	(601) 982 1031
Tupelo	(601) 842 3398
MISSOURI	
Jefferson City	(314) 893 4426
Springfield	(417) 887 2307
St Louis	(314) 849 6330
MONTANA	
Billings	(406) 248 1203
NEBRASKA	
Omaha	(402) 330 3753
NEVADA	
Las Vegas	(702) 878 3370
NEW HAMPSHIRE	
Manchester	(603) 668 1204
NEW JERSEY	
Bellmawr (So Jersey)	(609) 933 1800
Pine Brook (No Jersey)	(201) 575 7000
NEW MEXICO	
Albuquerque	(505) 828 1018
NEW YORK	
Binghamton	(607) 723 7337
Buffalo	(716) 836 5800
Mineola (New York City)	(718) 895 3150
Rensselaer (Albany)	(518) 449 1322
Rochester	(716) 424 4171
Syracuse	(315) 455 5324
White Plains	(914) 428 7790
NORTH CAROLINA	
Asheville	(704) 255 1325
Charlotte	(704) 376 1387
Greensboro	(919) 292 8995
Greenville	(919) 756 2117
Raleigh	(919) 782 1338
Wrightsville Beach (Wilmington)	(919) 256 9956
NORTH DAKOTA	
Fargo	(701) 235 7223
OHIO	
Akron	(216) 836 5593
Cincinnati	(513) 793 6811
Columbus	(614) 486 4329
Dayton	(513) 433 7771
Maple Hts (Cleveland)	(216) 581 3400
Toledo	(419) 535 1293
Youngstown	(216) 782 2295
OKLAHOMA	
Oklahoma City	(405) 942 7334
Tulsa	(918) 622 2800
OREGON	
Eugene	(503) 343 2591
Portland	(503) 684 1090
PENNSYLVANIA	
Altoona	(814) 942 1966
Bethlehem (Allentown)	(215) 694 9600
Camp Hill (Harrisburg)	(717) 761 4650
Erie	(814) 833 8424
Kingston (Wilkes Barre)	(717) 825 4569
Media (Philadelphia)	(215) 565 8750
Pittsburgh	(412) 343 7500
York	(717) 757 9421
RHODE ISLAND	
Cranston (Providence)	(401) 943 3380
SOUTH CAROLINA	
Charleston	(803) 556 0773
Columbia	(803) 772 3553
Greenville	(803) 288 6384
SOUTH DAKOTA	
Sioux Falls	(605) 334 2151
TENNESSEE	
Brentwood (Nashville)	(615) 371 8069
Chattanooga	(615) 877 1381
Kingsport	(615) 239 7948
Knoxville	(615) 524 7477
Memphis	(901) 682 8866
TEXAS	
Abilene	(915) 672 5022
Amarillo	(806) 372 1938
Austin	(512) 346 7120
Beaumont	(409) 866 7726
Corpus Christi	(512) 883 5566
Dallas	(214) 637 1491
El Paso	(915) 592 8813
Fort Worth	(817) 831 4579
Harlingen	(512) 423 1694
Houston	(713) 493 1300
(Northeast Houston)	(409) 265 3733
(Southeast Houston)	(713) 480 1039
Longview	(214) 753 5775
Lubbock	(806) 762 5736
Midland	(915) 694 8430
San Antonio	(512) 349 0197
Sherman	(214) 868 2720
Waco	(817) 776 3432
Wichita Falls	(817) 322 5589
UTAH	
Salt Lake City	(801) 466 8447
VIRGINIA	
Charlottesville	(804) 973 7069
Norfolk	(804) 461 1290
Richmond	(804) 285 7508
Roanoke	(703) 344 7707
WASHINGTON	
Mercer Island (Seattle)	(206) 232 9702
Spokane	(509) 535 3685
Tacoma	(206) 565 7730
WEST VIRGINIA	
Barboursville (Huntington)	(304) 736 8944
WISCONSIN	
Green Bay	(414) 494 3313
Madison	(608) 231 2244
Milwaukee	(414) 359 0959
Racine	(414) 554 9121
WYOMING	
Casper	(307) 234 1017

For start-up and testing, engineering and training services, maintenance agreements or time and material repair, contact:
TECHNICAL SERVICES DIVISION 1-800-634-2003.

Distributed By:

SQUARE D COMPANY
Transformer Division
P.O. Box 5002
Monroe, NC
(704) 283-7411
FAX (704) 283-

Bulletin TC 85 R
CP 15M
2 90
Printed in USA

OMM-XFR-1280 REV 7/86

Operation and Maintenance Manual

Ventilated Dry Type Transformers

Forced Air Cooling System

For Ventilated Dry or Cast Coil Transformers

NATIONAL INDUSTRI

ASEA BROWN BOVERI

Transformers **Ventilated Dry**

"THE INFORMATION HEREIN IS BELIEVED TO BE ACCURATE AND RELIABLE. HOWEVER, NATIONAL INDUSTRI ASSUMES NO RESPONSIBILITY FOR ITS USE OR MISUSE AND CAUTIONS THE READER TO EXERCISE CAUTION IN THE INSTALLATION AND MAINTENANCE OF THE PRODUCTS DESCRIBED HEREIN."

General

This manual addresses general considerations for the operation and maintenance of dry-type distribution and power transformers.

The successful operation of these transformers is dependent on proper installation, loading and maintenance, as well as proper design and manufacture. Dry type transformers require little maintenance as compared to other types of transformers, but appropriate attention will ensure their expected service life. Conditions of operation will determine the extent of maintenance required. A periodic inspection program should be established to monitor the effects of the operating conditions on the transformers.

In addition to this guide, the manufacturer should be consulted for recommeoations on special conditions.

Portions of the following information are re-printed from ANSI Appendix C57.94 Guide for Installation and Maintenance of Dry-Type Transformers.

Warning: *Lethal Voltages will be present inside all transformer enclosures and at all connection points. Installation and maintenance should be performed only by personnel qualified and experienced in high voltage equipment. De-energize the transformer before performing any maintenance or service work.*

Receiving

Inspection

When received, new transformers should be inspected for damage during shipment.

Examination should be made before removing them from cars or trucks, and, if any injury is evident or any indication of rough handling is visible, a claim should be filed with the carrier at once and the manufacturer notified. Subsequently, covers or panels should be removed and an internal inspection made for damage or displacement of parts, loose or broken connections, dirt or foreign material, and for the presence of water or moisture. If the transformer is moved or if it is stored before installation, this inspection should be repeated before placing the transformer in service.

Handling

National Industri transformers are designed with provisions for lifting, jacking or rolling. These provisions will vary in detail, depending upon the weight, size and mechanical configuration of the unit.

Enclosed transformers with lifting lugs on the enclosure may be lifted with appropriate slings or chains. Larger units will have provisions for lifting from the base frame or from the top core clamps. Units lifted from the top core clamps will usually require that the top cover or part of the cover be removed.

Caution: *Dry type transformers should be maintained in an upright position when being moved. No attempt to handle a transformer in any other position should be made without first contacting the manufacturer.*

Because of their high center of gravity, dry type transformers are subject to tipping over during handling. Reasonable care during handling will prevent equipment damage and/or personnel injury.

When provisions are supplied for lifting larger units from the base frame, lifting slings, chains, or cables should be used with spreaders to avoid damage to the enclosure. The core and coil must also be bolted to the base frame and anti-sway bracing provided.

Core and coil units should be lifted using only the lifting devices provided on the core clamps. Care should be taken to prevent damage to bus work, wiring and termination assemblies during lifting. When lifting, increase tension gradually; do not jerk, jar, or otherwise move the transformer abruptly.

If the transformer cannot be lifted by a crane, it can be skidded or moved on rollers. Care should be taken not to damage the base or tip it over. When rollers are used, skids should be used to distribute the stress over the base.

Large enclosed units with base frame type enclosures, may be jacked using the base frame angles. The transformers should be jacked evenly on all four corners to prevent warping or tipping over.

Care must always be taken to prevent any foreign

Installation

Handling (Continued)

material from falling into or onto the coils. Hardware, connecting parts, tools, or any foreign material should not be allowed on top of the core and coil assembly. Foreign material lodged in a coil duct can cause electrical failure or overheating.

NOTE: All lifting devices and shipping braces painted red must be removed before energizing the transformer.

Installation

Location

Major factors to be considered when locating dry type transformers are: personnel safety, accessibility, ventilation, atmospheric conditions, and sound level.

When planning the installation, a location should be selected that will comply with all safety codes and will not interfere with the normal movement of personnel, equipment, and material. The location should not expose the transformers to possible damage from cranes, trucks, or moving equipment. It should be remembered that a dent in the enclosure may reduce the insulation clearances to an unsafe level.

As an added safety precaution, thought should be given to the possibility of personnel inserting rods, wire, etc. through the ventilation openings of the enclosure and thus, coming into contact with live parts. Transformer ventilation openings are designed in accordance with NEMA standards which require that a ½" diameter rod cannot be inserted through the ventilation openings.

The installation will be simplified if an outline drawing is requested. By studying the overall, m[illegible]ting, and terminal dimensions, it is possible to p[illegible]ne installation with an orderly arrangement of connections.

Core and coil units (without case) usually have mounting and terminal dimensions to suit the customer's enclosure. That enclosure should give protection to the coils and have adequate clearances and sufficient ventilation openings. The manufacturer should always be consulted to determine these requirements.

Ventilated dry type transformers can be designed for installation indoors or outdoors. They will operate successfully where the humidity is high, but under this condition it may be necessary to take precautions to keep them dry if they are shut down for extended periods. For locations where severe atmospheric conditions prevail, National Industri's Vacuum Cast Coil transformers are recommended.

Locations where there is dripping water should be avoided. If this is not possible, suitable protection should be provided to prevent water from entering the transformer case. Precautions should be taken to guard against accidental entrance of wa[illegible] such as might be obtained from an open window, by a break in a water or steam line, or from use of water near the transformers.

Caution: *Adequate ventilation must be provided for Dry Type Air-Cooled Transformers.*

Adequate ventilation is essential for the proper cooling of these transformers. Clean dry air is desirable. Filtered air may reduce maintenance if the location presents a particular problem. When transformers are installed in vaults or other restricted spaces, sufficient ventilation should be provided to hold the a[illegible] temperature within established limits when [illegible]easured near the transformer inlets. This usually will require approximately 100 cubic feet of air per minute per kilowatt of transformer loss. The area of ventilation openings required depends on the height of the vault, the location of openings, and the maximum loads to be carried by the transformers. For self-cooled transformers, the required effective areas should be at least one square foot each of inlet and outlet per 100 KVA of rated transformer capacity, after deduction of the area occupied by screen, gratings, or louvers.

Ventilated open wound dry type transformers should be installed in locations free from unusual dust or chemical fumes. Transformers should be located at least 12 inches away from walls and other obstructions that might prevent free circulation of air through and around each unit, unless the unit is designed for wall mounting and installed per factory recommendations. The distance between adjacent transformers should be not less than this value. Also, accessibility for maintenance should be taken into account before locating the transformer. If the transformer is to be located near combustible materials, the minimum separations established by the National Electrical Code should be maintained.

The transformer case [illegible] designed to prevent the entrance of most sm[illegible] animals and foreign objects. However [illegible] some locations, it may be necessary to give cons[illegible]eration to additonal protection.

Sound Level

Special consideration should be given to the installation of any transformer if noise is a factor in its location and operation. Many locations can result in an amplification of the sound level. For example, if the transformer is installed in a quiet hallway, a definite hum will be noticed. If the unit is installed in a location it shares with other equipment such as motors, pumps or compressors, the transformer hum will probably go unnoticed.

Installation

Sound Level (Continued)

The transformer is designed to produce a minimum sound level when the following directions are followed

A Connections to primary and secondary terminals made with flexible connectors

B All transit bolts and shipping braces removed so unit will float on rubber isolation pads, these bolts and parts are painted red for easy identification

C All enclosure hardware tightened so panels do not vibrate

Inspection

Once the transformer has been located at its permanent site, a thorough final inspection should be made before any necessary assembly is accomplished and the unit is energized

Careful examination should be made to ensure that all external electrical connections have been made properly and that the correct ratio exists between low voltage and high voltage windings To test this, apply a low voltage (240V or 480V) to the high voltage winding and measure the output at the low voltage winding

All control circuits, if any, should be checked for operational ability Furthermore, they should be able to withstand a 1200 volt applied insulation test for one minute (if the transformer has current transformer circuits, they should be shorted).

The operation of fans, motors thermal relays, and other auxiliary devices should be checked Fan rotation should be visually verified as well as by checking any indicator lights (Reference Fan Control Operation)

As prescribed by NEMA standards, transformers are shipped with both high and low voltage windings connected for their highest rated voltage (except transformers which have taps above the rated voltage in which case they will be shipped connected for rated voltages) The internal connections should be checked with the diagram on the nameplate to make sure that the connections are correct The tap setting should also be verified for the proper voltage, and that the setting is the same for all coils

All windings should be checked for continuity It is recommended that a megger test be performed to make certain that no windings are grounded which are not intended to be grounded

See "**Testing**" for additional tests Shipping braces should be removed if present All cable connections should be checked for proper use of hardware (i e Belleville washers on aluminum terminals, proper clearances and proper torque)

Check again to insure that all low voltage and high voltage connections correspond to the connection diagram

Grounding

The case and core and coil assembly of these transformers should be permanently and adequately grounded

Grounding is necessary to remove static charges that accumulate It is also needed as a protection should the transformer windings accidently come in contact with the core or enclosure. Be sure that the flexible grounding jumper between the core and coil assembly and case is intact, or that the core and coil assembly is directly grounded from the core clamp through a flexible lead. Insure that grounding or bonding meets N.E.C and local codes.

To insure a solid core ground, transformers have a copper strap embedded in the core laminations and securely connected to the core clamp.

Connections

Make only those connections specified by the nameplate or connection diagram, check all tap jumpers for proper location and tightness, and re-tighten all aluminum cable retaining screws after the first 30 days of service

This transformer has been designed and built to provide proper electrical connections using either copper or aluminum connecting cable A protective plating or compound which prevents surface oxidation of the terminals was applied at the factory This coating should not be removed from tap or line terminals If in the case of protective compounds it becomes necessary to re-apply it, clean all contact surfaces of oxide and re-coat with a good quality compound, following the manufacturer's instructions Many kinds are commercially available Some of them are Penetrox A, Alnox-UG, and Thomas & Betts 1059 When re-coating, wipe off any excessive compound

Depending upon KVA rating, this transformer may have flexible leads with bolted type wire terminals, Cu Al lug connectors or simply termination pads for mounting of your own crimp type or lug type terminations The tables below show typical torque values for installing bolted wire connectors and cables in lug type connectors Check specific recommendations of

Grounding

Connections (Continued)

connector or lug manufacturer.

Bolted Wire Connectors		Lug Type Connectors	
Bolt Size	Torque Inch Pounds	Wire Size (Average)	Torque Inch Pounds
1/4 - 20	70	#14 to #8	70
5/16-18	120	#6 to #4	100
3/8 - 16	225	#3 to #1	120
1/2 - 13	480	1/0 to 2/0	150
		3/0 to 200 MCM	210
		250 to 400 MCM	260
		500 to 750 MCM	300

Note: *Tighten, wait several seconds, then re-tighten all connecting lugs and bolts.*

Where cable terminations are supplied by the user, it is recommended that commercially available, properly sized, UL listed screw type or crimp type connectors be used. These terminations should be attached to the cables as specified by the termination or cable manufacturer. Terminations are readily available from wholesale electrical distributors.

Secure each terminal lug to its proper termination bus bar. Torque all bolts as shown in the bolted wire connector chart above. Do not install washers between the terminal lugs and the termination bus bar as this will cause heating and arcing in that area, resulting in connector failure.

Testing

Tests may be made before placing a transformer in service to determine that it is in satisfactory operating condition and to obtain data for future comparisons.

A. Insulation resistance.

B. Dielectric tests in the field in accordance with ANSI C57.12.91.

The insulation resistance test aids in determining the suitability of the transformer for application of the high-potential test and yields useful data for future comparative purposes. Insulation resistance tests should be made before applying the high-potential test. Variable factors affecting the construction and use of dry-type transformers make it difficult to set limits for this test. Experience indicates that 2 megohms (one minute reading at approximately 25°C) per 1,000 volts of nameplate voltage rating, but in no case less than 2 megohms total, may be a satisfactory value of insulation resistance for the application of the high-potential test.

In addition to the insulation resistance and high-potential dielectric tests, the following tests may be made if desired.

A. Ratio tests for the full windings and all tap positions.

B. Resistance measurements of windings.

C. Polarity or phase relation.

It is preferable that these tests, if planned, be made before applying the dielectric tests.

Operation

Placing in Service

After following the preceding instructions, the transformer may be energized. It is recommended that the unit first be energized at no load if possible, then full load may be applied.

Parallel Operation

When operating transformers in parallel, their rated voltages, impedances, and turn ratios ideally should be the same. Their phasor relationships must be identical. If these parameters are different, circulating current will exist in the circuit loop between these units. The difference in impedance should in no case exceed 10%. The greater the differences in these parameters the larger the magnitude of the circulating current. When specifying a transformer to be operated in parallel with existing units, all of these parameters should be noted.

Loading

The maximum continuous load a transformer may supply is indicated on the nameplate. However, many specially designed units have specific load capabilities designed into them. If there is any question concerning the load capability of the unit, the factory should be consulted. Refer to ANSI Standard C57.96 Guide for Loading Dry-Type Distribution and Power Transformers for general guidelines.

Minimum electrical clearances in the installation of lugs and cables must be per N.E.C. All electrical clearances that are questionable must be insulated.

Overload protection for primary and secondary circuits is covered by the National Electrical Code.

Operation

Shipping Supports

After the transformer has been placed in its permanent location the hold-down bolts securing the core and coil assembly to the base or case must be removed Removing these bolts releases the sound isol: on pads for maximum effectiveness Also remove any shipping braces and lifting devices the core and coil or the enclosure For easy iden ication, all of these removable parts will be painted a different color from the remaining assembly parts (usually red)

Should it ever be necessary to move the transformer, replace the hold-down bolts for the moving operation

Maintenance

Warning: De-energize transformer before any inspection or maintenance!

Periodic Inspection

Like other electrical equipment all transformers require maintenance from time to time to assure successful operation Inspection should be made at regular intervals and corrective measures taken when necessary to assure the most satisfactory services from this equipment

Operating conditions determine the frequency at which these transformers should be inspected. For clean dry locations, an annual inspection may be sufficient However, for other locations, such as may be encountered where the air is contaminated with dust or chemical fumes, more frequent inspections may be required Usually after the first few inspection periods a definite schedule can be established.

With the transformer de-energized, enclosure panels should be removed Inspection should be made for dirt especially accumulations on insulating surfaces where such accumulations could restrict air flow Inspection should also be made for loose connections for the condition of terminal boards, and for the general condition of the transformer

Observations should be made for signs of overheating and of voltage creepage over insulating surfaces as evidenced by tracking or carbonization

Evidence of rusting corrosion and deterioration of the paint should be looked for and corrective measures should be taken where necessary Furthermore fans, motors and other auxiliary devices should be inspected and serviced during inspection periods

Jackscrew Assembly Adjustments

Check for loose jackscrew assemblies by attempting to move the coil block from side to side If they move, tighten the jackscrew assembly following the outlined procedure (Caution should be observed when handling nuts, bolts and washers to prevent dropping them into the coils)

A Tighten lower jacking nut while holding jacking bolt until coil block can no longer be moved by hand

B Tighten lower jacking nut an additional ' turn

C Apply air dry varnish to nut and bolt assembly

D Repeat as required on other jackscrew assemblies

Determining Dryness

The measurement of insulation resistance is of value in determining the status of drying Measurements should be taken before starting the drying process and at two-hour intervals during drying The initial value, if taken at ordinary temperatures, may be high even though the insulation may not be dry Because insulation resistance varies inversely with temperature, the transformer temperature should be kept approximately const nt during the drying period to obtain comparative r adings. As the transformer is heated, the presence of moisture will be evident by the rapid drop in resistance measurement. Following this period, the insulation resistance will generally increase gradually until near the end of the drying period when it will increase more rapidly. Sometimes it will rise and fall through a short range before steadying, because moisture in the interior of the insulation is working out through the initially-dried portions A curve, with time as abscissa and resistance as ordinate, should be plotted, and the run should be continued until resistance vels off and remains relatively constant between t e and four hours.

Caution: *Insulation resistance measurements should be taken from each winding to ground, with all windings grounded except the one being tested*

Before taking insulation resistance measurements, the winding should be short-circuited and grounded for at least one minute to drain off any static charge

All readings should be for the same time of application of the test voltage, preferably one minute

Methods of Drying

General

As long as the transformer remains energized humidity conditions are of no importance However if a dry-type transformer is de-energized and allowed to cool to ambient temperature,consideration must be given to the possible effects of humidity

If the shutdown period occurs during low humidity conditions, no special precautions should b quired before energizing the unit But, experience cates that if a shutdown exceeding 24 hours occ during a period of high humidity, particularly if atmospheric conditions are such that they cause condensation to

Maintenance

Methods of Drying (Continued)

appear within the housing of the transformer, then precautions must be taken. Small strip heaters may be placed in the bottom of the unit shortly after shutdown to maintain the temperature of the transformer a few degrees above that of the outside air. If such a precaution is not taken, the transformer should be inspected for evidence of moisture, and the insulation resistance should be checked. If moisture is present or if the insulation resistance is low, the transformer should be dried out by one of the methods described.

Drying of Core and Coil Assembly

When it is necessary to dry out a transformer before installation or after an extended shutdown under relatively high humidity conditions, one of the following methods may be used:

A. External heat

B. Internal heat

C. External and internal heat

Before applying any of these methods, free moisture should be blown or wiped off of the windings to reduce the time of the drying period.

Drying by External Heat

External heat may be applied to the transformer by one of the following methods:

A. By directing heated air into the bottom air inlets of the transformer case.

B. By placing the core and coil assembly in a suitably ventilated oven.

It is important that most of the heated air passes through the winding ducts and not around the sides.

Good ventilation is essential to prevent condensation from taking place within the transformer or inside the case. A sufficient quantity of air should be used to insure approximately equal inlet and outlet temperatures.

When using the first external heating method, heat may be obtained by the use of resistance grids or space heaters. These may be located inside the case or may be placed outside and the heat blown into the bottom of the case. The core and coil assembly should be carefully protected against direct radiation from the heaters.

It is recommended that the air temperature not exceed 110 C.

Drying by Internal Heat

This method is relatively slow and should be used only when the other two methods are unavailable.

The transformer should be located to allow free circulation of air through the coils from the bottom to the top of the case. One winding should be short-circuited, and sufficient voltage at normal frequency should be applied to the other winding to circulate approximately normal current.

It is recommended that the winding temperature not be allowed to exceed 100 C, as measured by resistance, or by thermometers placed in the ducts between the windings. The thermometers used should be the spirit type; mercury thermometers give erroneous readings due to the generation of heat in the mercury resulting from induced eddy currents. The end terminals of the windings (and not the taps) must be used in order to circulate current through the entire winding. **Proper precautions should be taken to protect the operator from dangerous voltage.**

Drying by External and Internal Heat

This is a combination of the two methods previously described and is by far the quickest method. The transformer core and coil assembly should be kept in its own case when suitable, and external heat applied (as described in the first method) as current is circulated through the windings (as described in the second method). The current required will be considerably less than when no external heating is used, but should be sufficient to produce the desired temperature of the windings. It is recommended that the temperature attained not exceed those stated in the foregoing paragraphs.

Removal from Service

If a unit is to be off more than 24 hours, provisions should be made to prevent the core and coils from taking on moisture. Refer to "Storage."

If the unit is be moved, it will be necessary to replace the core and coil hold-down bolts and any shipping braces that might protect the assembly during movement.

Cleaning

If excessive accumulations of dirt are found on the transformer windings or insulators when the transformer is inspected, the dirt should be removed to permit free circulation of air and to guard against the possibility of insulation breakdowns. Particular attention should be given to cleaning the top and bottom ends of the windings assemblies and to cleaning out the ventilating ducts.

The windings may be cleaned with a vacuum cleaner, a blower, or with compressed air. The use of a vacuum

Maintenance

Methods of Drying (Continued)

cleaner is preferred as the first step in cleaning, followed by the use of compressed air or nitrogen. The compressed air or nitrogen should be clean and dry and should be applied at a relatively low pressure (not over 25 pounds per square inch). Lead supports, terminal boards, bushings and other major insulation surfaces should be brushed or wiped with a dry cloth. The use of liquid cleaners is discouraged as some of them have a solvent or deteriorating effect on insulating materials.

Renewal Parts

Should a transformer be damaged and new parts needed, write to National Industri giving full nameplate information. Be sure to include the serial number and a description of the part desired. If the proper name of the part is in doubt, a simple sketch or photograph will expedite prompt shipment to you.

Transformers

Ventilated Dry

Trouble Shooting

Transformer failure may occur in either the electric, magnetic or dielectric circuit.

Symptom	Cause
	Electric Circuit
Overheating	Continuous overload — wrong external connections - poor ventilation - high surrounding air temperature. (Rating is based on 30 Degree C average temperature over 24-hour period with peaks not to exceed 40 Degree C.)
Reduced or Zero Voltage	Shorted turns - loose primary tap connections
Excess Secondary Voltage	Input voltage high - improper primary tap connections
High Conductor Loss	Overload - tap connections not on identical tap positions
Coil Distortion	Coils short circuited
Insulation Failure	Continuous overloads - dirt accumulations on coils - mechanical damage in handling - lightning surge.
Breakers or Fuses Opening	Short Circuit - overload.
Excessive Cable Heating	Improper bolted connection.
High Voltage to Ground (using rectifier or VTVM meter)	Usually a static charge condition.
	Magnetic Circuit
Vibration and Noise	Low frequency - high input voltage - core clamps loosened in shipment or handling - improper primary tap connection.
Overheating	High input voltage.
High Exciting Current	Low frequency - high input voltage - shorted turns.
High Core Loss	Low frequency - high input voltage.
Insulation Failure	Very high core temperature due to high input voltage or low frequency.
	Dielectric Circuit
Smoke	Insulation failure.
Burned Insulation	Lightning surge - switching or line disturbance - broken bushings, taps, or arrestors - excess dirt or dust on coils.
Overheating	Clogged air ducts or inadequate ventilation.
Breakers or Fuse Open	Insulation failure.

If any of the above symptoms are noticed, the transformer should be removed from service at once. Immediate attention to the problem may save a large repair bill. In many instances, the trouble can be found quickly and the unit returned to service.

If the trouble cannot be definitely corrected, no further use should be made of the transformer until the cause has been found.

It may be necessary to remove the core and coils for a closer examination. If no apparent fault can be found the core and coil may have to be disassembled for a complete inspection. Removal of the coils from the core is a factory or service shop operation. As this will mean replacing many insulation parts when reassembling, it is advised that the trouble be reported to the nearest National Industri representative, before any dismantling takes place. Factory advice may again save a large repair bill. When writing, describe the nature of the trouble, the extent and character of the damage, and list all nameplate information.

Transformers

Forced Air Cooling System

Ventilated Dry and Cast Coil Transformers

Application Data

The forced air cooling system is designed for use with ventilated dry-type and cast coil transformers. Forced air cooling is available on transformers 300 - 3750 KVA to supply an additional 33-1/3% of overload capability to ambient air rating. Consult factory for overload capabilities above 3750 KVA and special applications not mentioned above.

Description

National Industri Transformers, Inc. offers 3 options in forced air cooling equipment. The 3 basic options include the following equipment:

Option A — Future Forced Air Cooling

1. Insulated tube well in low voltage winding for future addition of temperature sensing device
2. Properly sized bus for increased capacity of transformer
3. A control box with a hinged blank door

Option B — Provision For Future Forced Air Cooling

4. All items described under Option A
5. A hinged door with dial type temperature indicator with 3 SPDT adjustable alarm contacts, and a maximum temperature indicating pointer with reset

Option C — Complete Forced Air Cooling

6. Fan mounting brackets for maximum cooling efficiency
7. All items described under Option B
8. Automatic control panel equipped with indicating lights and alarm bell
9. Fan motors and blades
10. 120 VAC power source supplied if specified at time of order entry

Ordering Information

To order forced air cooling equipment select from the description above Option A, B or C and so state that selection on order.

Control Power

Control power should be supplied by customer from any available 120 VAC supply. The amount of power required for operation of the Fan cooling system will vary with size of transformer being supplied. General requirements for transformers up to 3000 KVA (ambient air rating) 1500 VA. Consult factory for larger transformers. If 120 VAC control power is not available, control power may be furnished by factory from the secondary of the main transformer if specified at time of order entry. In cases where control power is to be supplied by the factory the customer's order should be written e.g. 1500/2000 AA/FA Option C Forced Air Cooling, with control power.

3 coil sensing is available as a separate package - consult factory.

Future Addition of Forced Air Equipment

Forced air equipment may be added in the field to transformers that were equipped by the factory with Future Forced Air or Provision For Future Forced Air Cooling (Option A and B). Most units that require the addition of a fan cooling system can be readily modified in the field. Some of the units which have been in service for longer periods of time may require a more extensive conversion process. When ordering equipment for completion of forced air cooling, the serial number of the unit on which fans are being added must be supplied with the order.

National Industri reserves the right to alter any of the equipment described in this information.

Forced Air Cooling Equipment

KVA	(1) No. of Motors	(2) Fan Blade Diameter
300	6	7"
301-500	6	8"
501-750	6	9"
751-1250	6	10"
1251-2000	12	9"
2001-3000	12	10"
Above 3000	(3)	(3)

Table 1

Notes:

(1) Fan motors are 1550 RPM, 120 Volt, 0.7 Amp, 1/83 H.P. each.
(2) Fan blades are uncoated aluminum.
(3) Consult factory.

Ventilated Dry and Cast Coil Transformers

Thermostat

The control circuit elements are actuated by thermometer contacts in the Qualitrol model 104-075-01 temperature indicator assembly

The thermostat is of the bourdon-tube type and is connected with capillary tubing to a bulb installed directly in the air duct of the center transformer coil, where it transmits the winding hot-spot temperature

Forced Air Cooling Equipment Contact Settings

Contacts				(1) 220°C Max Total Temperature	(2) 185°C Max Total Temperature	(3) 150°C Max Total Temperature
	Contact Position	Recommended Circuits	Dead Band			
[illegible]	Left	Fan Control	17[illegible]°C	180°C	145°C	110°C
T	Center	Alarm	5°C	210°C	175°C	140°C
T	Right	Auxiliary	5°C	220°C	185°C	150°C

Table 2

(1). Standard settings for conventional Open-Wound Transformer Forced Air Cooling System. Used on 80°C. 100°C 115°C, and 150°C Rise Transformers unless specified otherwise

(2) Standard settings for Cast-Coil Transformer Forced Air Cooling System. Used on 80°C. 100°C, and 115°C Rise Transformers unless specified otherwise.

(3) Optional Settings for Cast-Coil and Open-Wound Transformers Forced Air Cooling System. Used when 80°C is to be maintained at Forced Air Cooling Rating

Field Conversion from Option A — Provisions for Forced Air Cooling to Option B — Future Forced Air Cooling.

A tube-well in the center coil of the transformer will normally be provided for most installations If no tube-well exists in older units, consult factory for details

The temperature sensing bulb of the temperature indicator should be fully inserted into the tube-well as shown on Fig 4

Proper air clearances must be maintained from any transformer live part to capillary tubing and temperature indicator. General guidelines for such clearances are: up to 5 KV — 2½", up to 15 KV — 6".

Replace hinged blank door over cutout in transformer enclosure with temperature indicator panel with indicator and terminal block attached. Indicator contacts are available on this terminal block for connection to remote devices, see Fig. 1.

Field Conversion from Option B — Future Forced Air Cooling to Option C — Complete Forced Air Cooling

Fan mounting brackets, if not already installed, should be mounted as per Fig 6 Use existing bolts in bottom flange of bottom transformer clamping channel if available and if in appropriate position. Otherwise weld brackets to the bottom flange.

Remove hinged indicator panel from cutout in transformer enclosure and replace with FAC control panel. Connect contact wires to terminal block on rear of control panel per terminal numbers as shown on Fig. 7.

Fan motors should be mounted on the mounting brackets using lock washers on all screws Fan blades and rubber sound/vibration reducing washer should be installe[illegible] locating pins, and secured with lock washer an[illegible].

Wire six fan motors in parallel and connect to terminal points 1 and 2 on terminal block on rear of FAC control panel. If 12 motors are required, wire the remaining six motors in parallel and connect to points 3 and 4. Connect 120 VAC to terminal points 11 and 12 on same terminal block.

Transformers

Forced Air Cooling System

Ventilated Dry and Cast Coil Transformers

If CPT is required, mount unit and fuses in a suitable location and connect as per Fig 9

Proper air clearances must be maintained between all transformer live parts and fan motors, blades and all control wiring

For digital units see separate instruction manual

Temperatue Indicator Contact Wiring

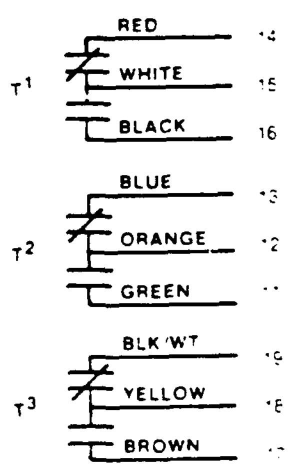


Fig. 1

1. The temperature indicator is equipped with 3-SPDT contacts, each independently adjustable over a broad temperature range.
2. Contact Rating: 10 Amp @ 125/250 VAC
   .5 Amp @ 125 VDC (Non-inductive)
   .25 Amp @ 250 VDC (Non-inductive)
3. Contacts are wired to control elements in FAC panel in Option C or to customer termination points for connection to remote devices in Option B
4. Contact settings are normally factory preset. For possible field adjustments refer to Table 2

Dry and Cast Coil Transformers

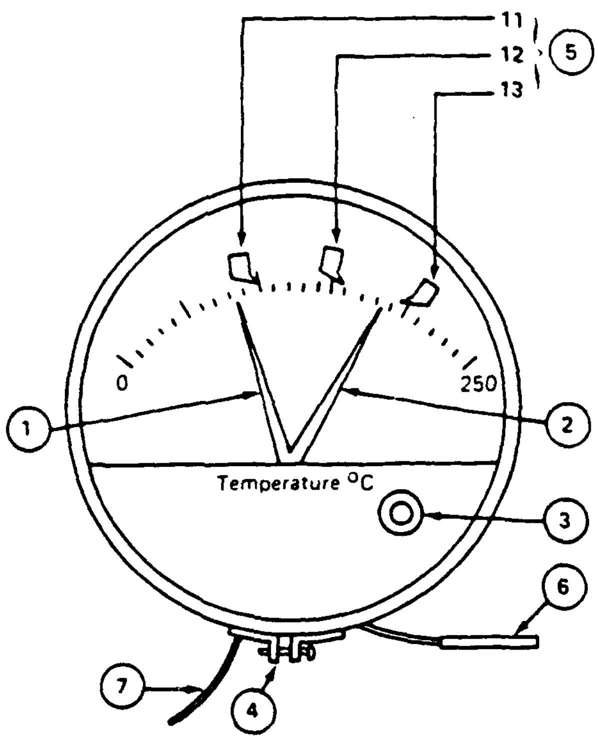


Fig. 2

Temperature Indicator

1. Black temperature indicating pointer.
2. Red maximum temperature pointer.
3. Maximum temperature pointer reset button.
4. Removable bezel ring for access to contact settings.
5. Three adjustable contacts for connection to remote controls and alarm.
6. Temperature sensing bulb.
7. Contact leads.

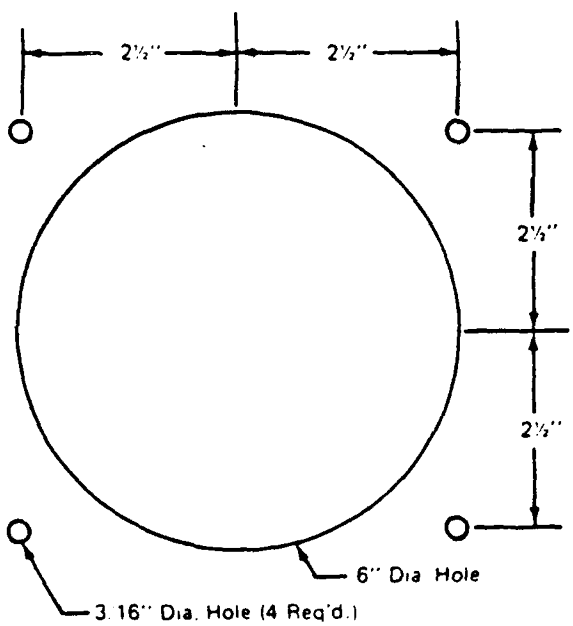


Fig. 3

Field Installation of Temperature Indicator

1. When indicator is supplied for fie_ installation in an enclosure which does not have provision for mounting of device, the cutout and drilling shown at left will be required.
2. Cutout should be made in non-removable panel.
3. Mount indicator with flange inside of pane!
4. Cutout should be in a location that provides adequate clearance to transformer live parts. Indicator extends 3½" inside of panel.

Dry and Cast Coil Transformers

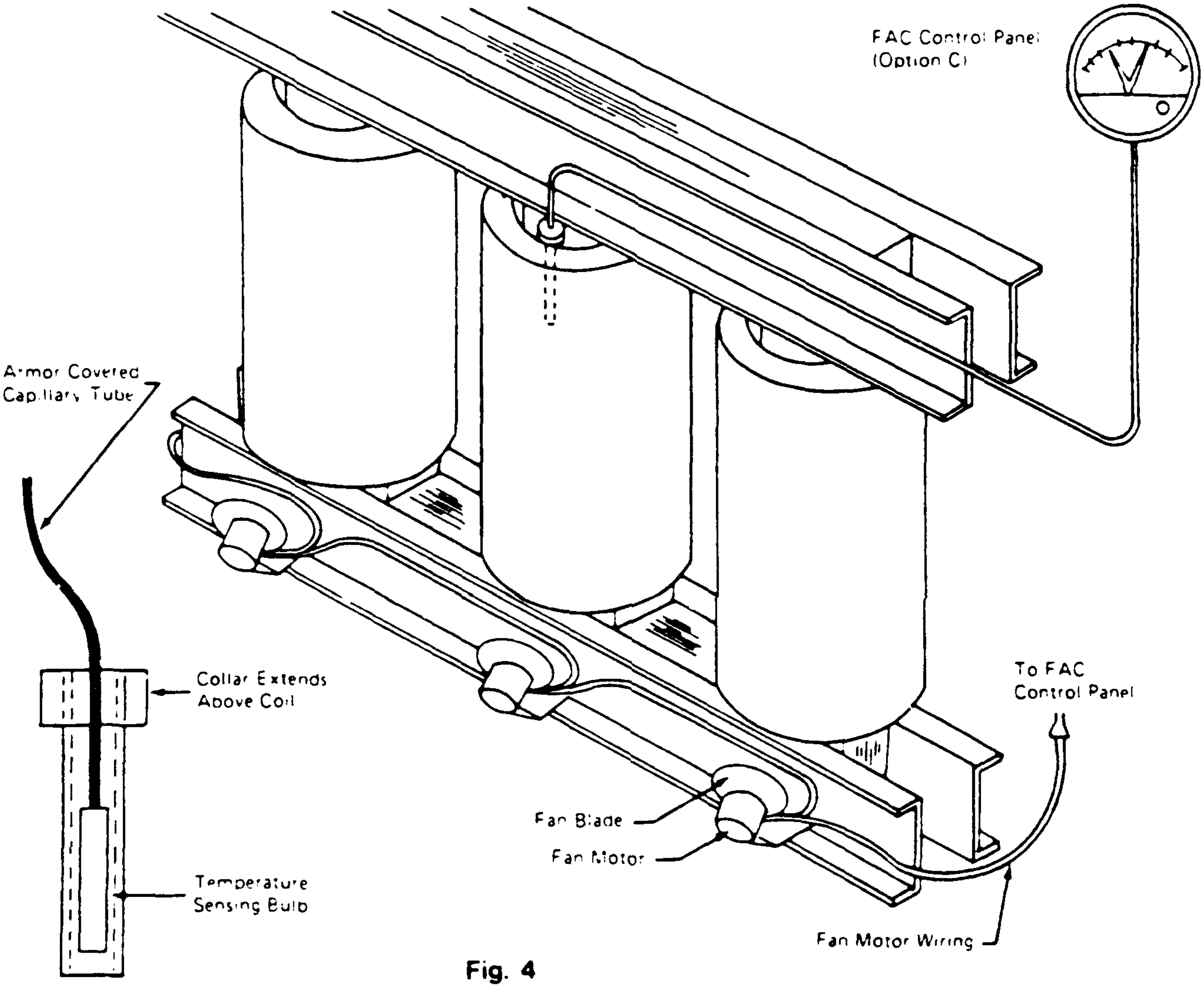


Fig. 4

Detail of Insulated Well

Notes 1 Install indicator such that adequate clearance to live parts is maintained for indicator and capillary tubing

2 Exercise care not to crush sensing bulb and not to make sharp bends in capillary tube Coil excess length of capillary tube and support to prevent damage to tube

3 Route fan motor wiring to maintain adequate clearance to transformer live parts

Dry and Cast Coil Transformers

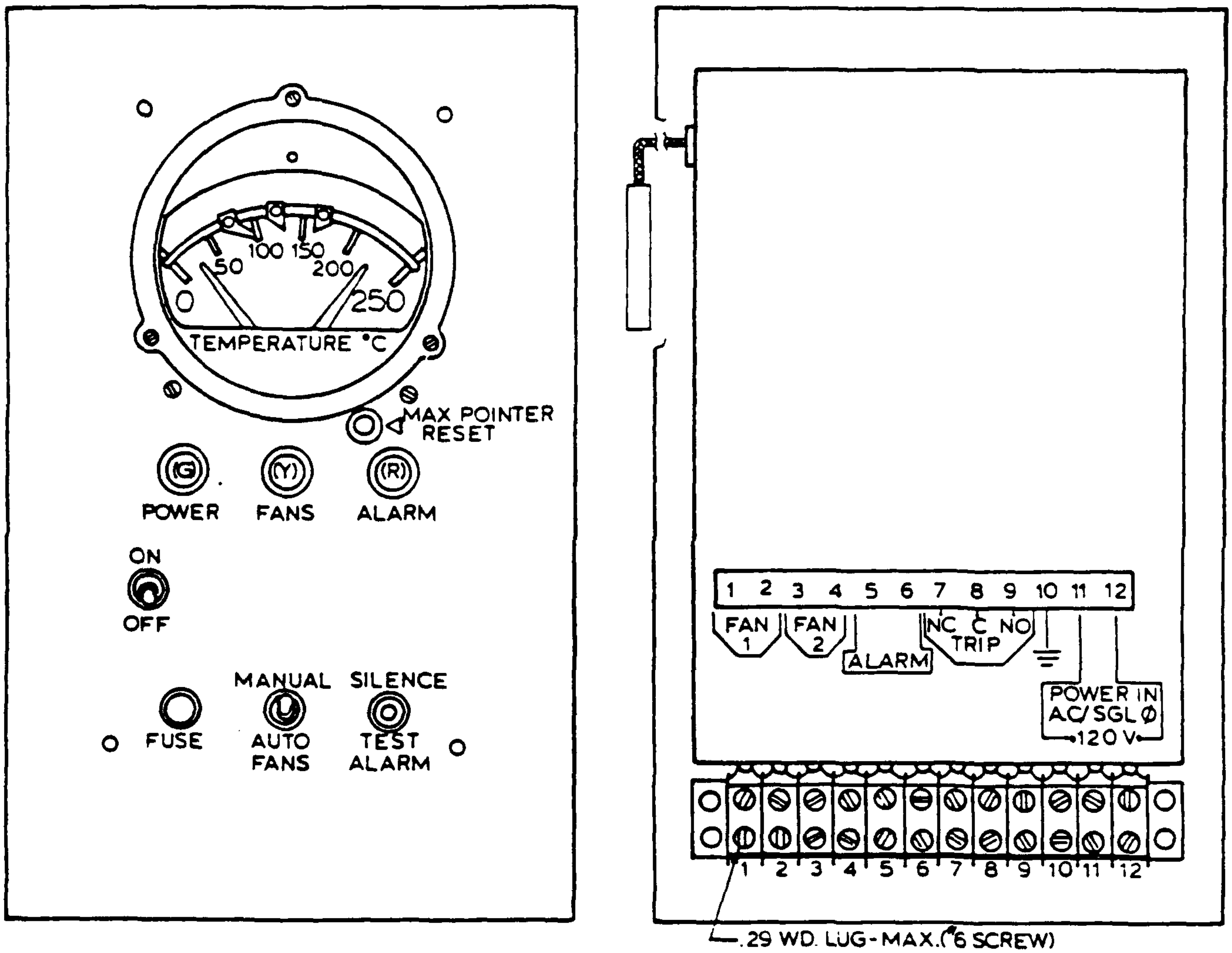


Fig. 5

Dry and Cast Coil Transformers

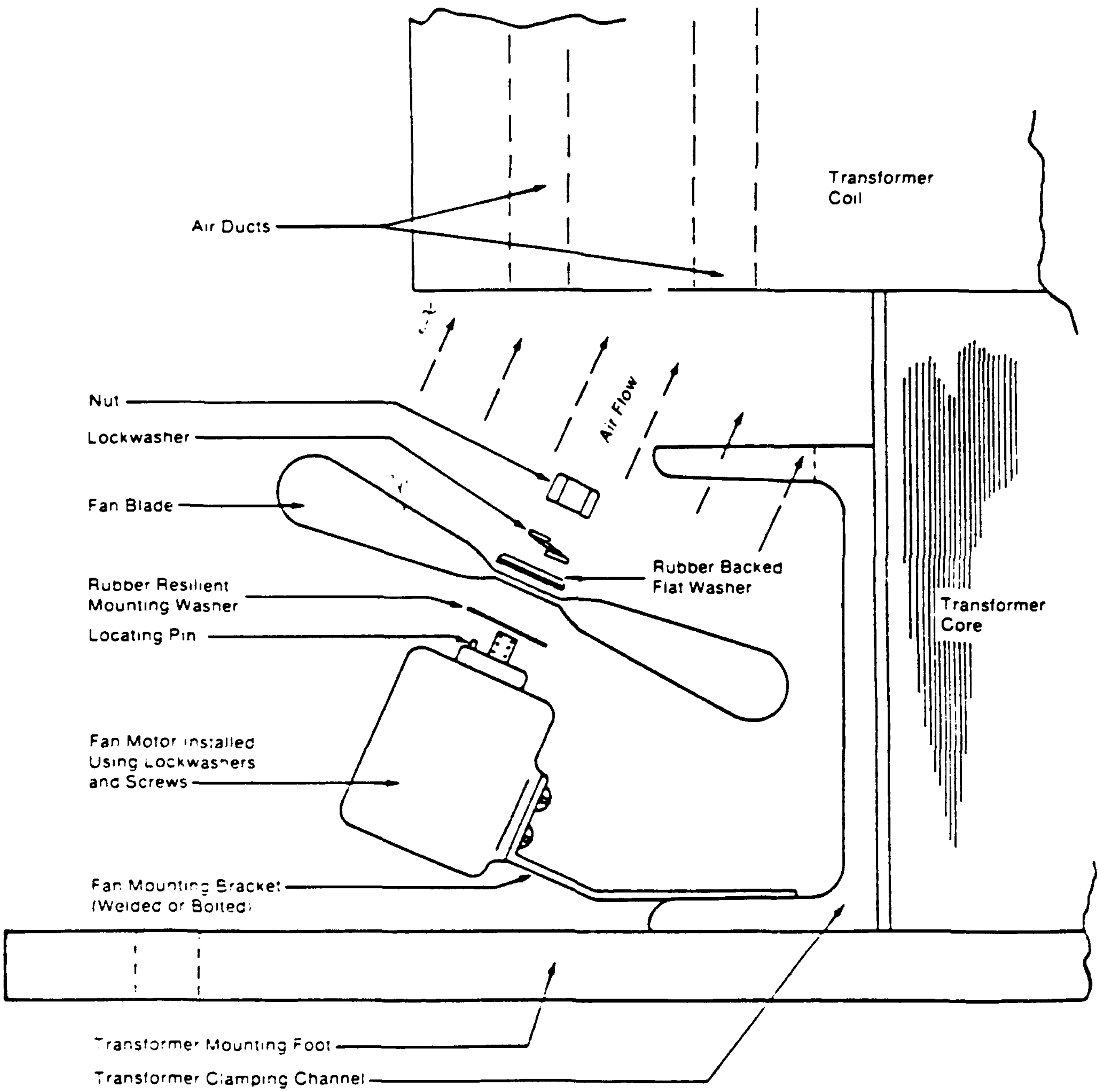


Fig. 6

Dry and Cast Coil Transformers

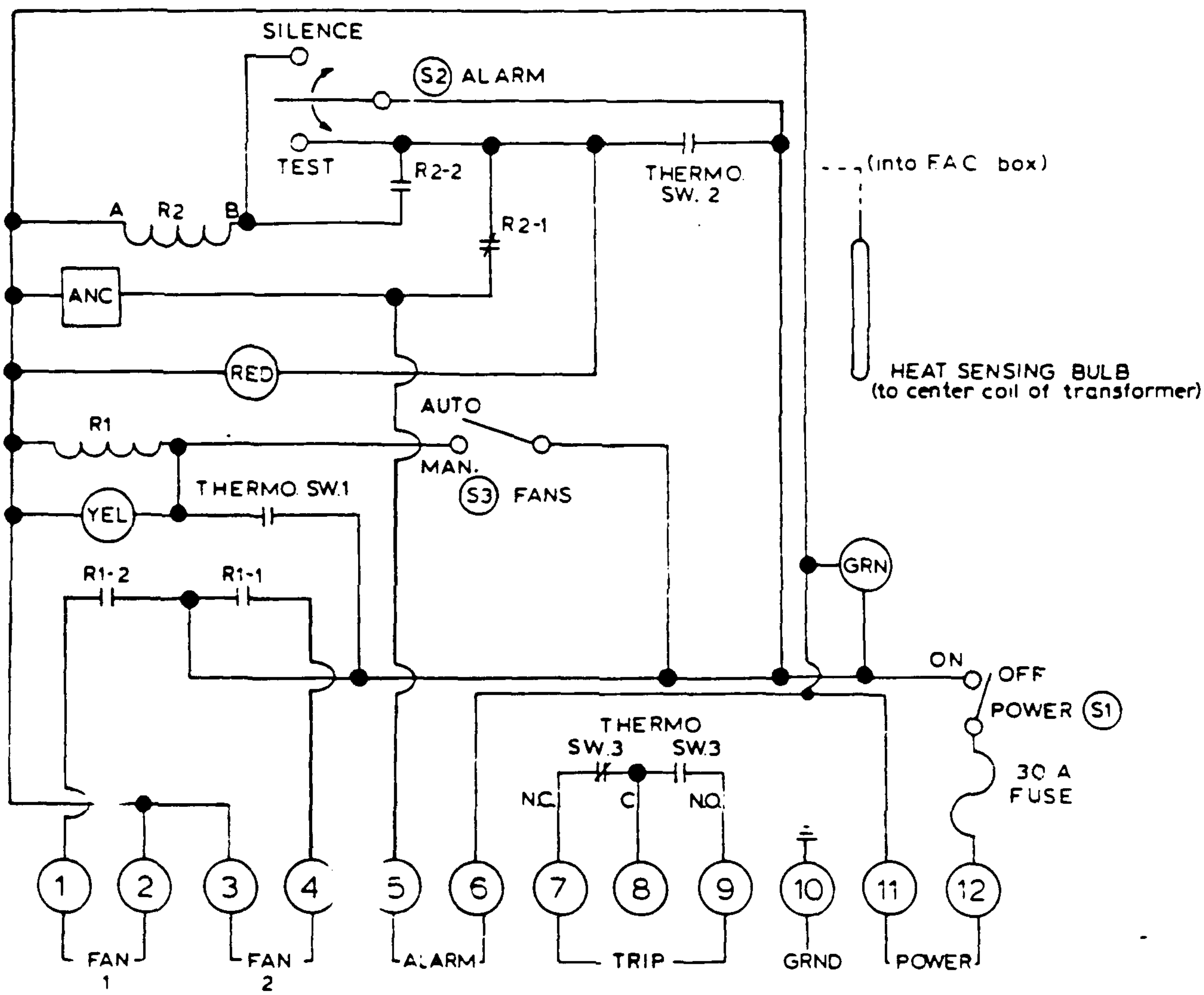


Fig. 7

Dry and Cast Coil Transformers

FAC Instructions

1 Supply of 120 volts - 60 Hz or 100 volts - 50 Hz to points 11 and 12 of control panel

2 Panel is de-energized with main switch in "OFF" position

3 With circuit breakers in "ON" position the green "POWER" pilot light indicates that panel is energized. Transformer may be operated at it's forced air rating only if this light is on

4A Move "FANS" switch to "AUTO" position. This is the normal position for operating fan controller. When the temperature of T1 contact is reached, contact T1 closes, the amber "FANS" light is energized, fan motors operate. The fan motors and the "FANS" light will continue to operate until the temperature falls 15-20° C below T1 contact setting

4B Move "FANS" switch to "MANUAL" position. This funcitor by-passes the automatic controls and operates fan continuously. This position should be used only for emergency operation or testing of fan motors

5 If temperature continues to rise above T1 contact setting and T2 contact setting is reached, contact T2 closes, energizing the red "ALARM" light, the local annunciator, and the remote "ALARM" contacts on the rear terminal board. The local annunciator and the remote "ALARM" contacts may be de-energized by momentarily moving the "ALARM" switch to "SILENCE" position, while overload condition is being adjusted. The red "ALARM" light will remain lighted until temperature falls 5-10° C below T2 contact saetting. The "ALARM" circuit also resets itself at this point

6 Move "ALARM" switch to "TEST" position to test operation of the "ALARM" light, local annunciator, and remote "ALARM" relay operation. The red "ALARM" light, local annunciator, and remote "ALARM" relay will all remain actuated as long as the "ALARM" switch is held in the "TEST" position.

7A Auxiliary circuit for remote "ALARM" connections are provided at points 5 and 6. Device should be rated maximum 120 vac, 3 amps. Power is provided from fan control panel

7B Auxiliary circuit for remote "TRIP" connections are provided at points 7, 8 and 9. Device should not exceed 3 amps 125/250 vac and should include its own source of supply power.

Transformers

Forced Air Cooling System

Dry and Cast Coil Transformers

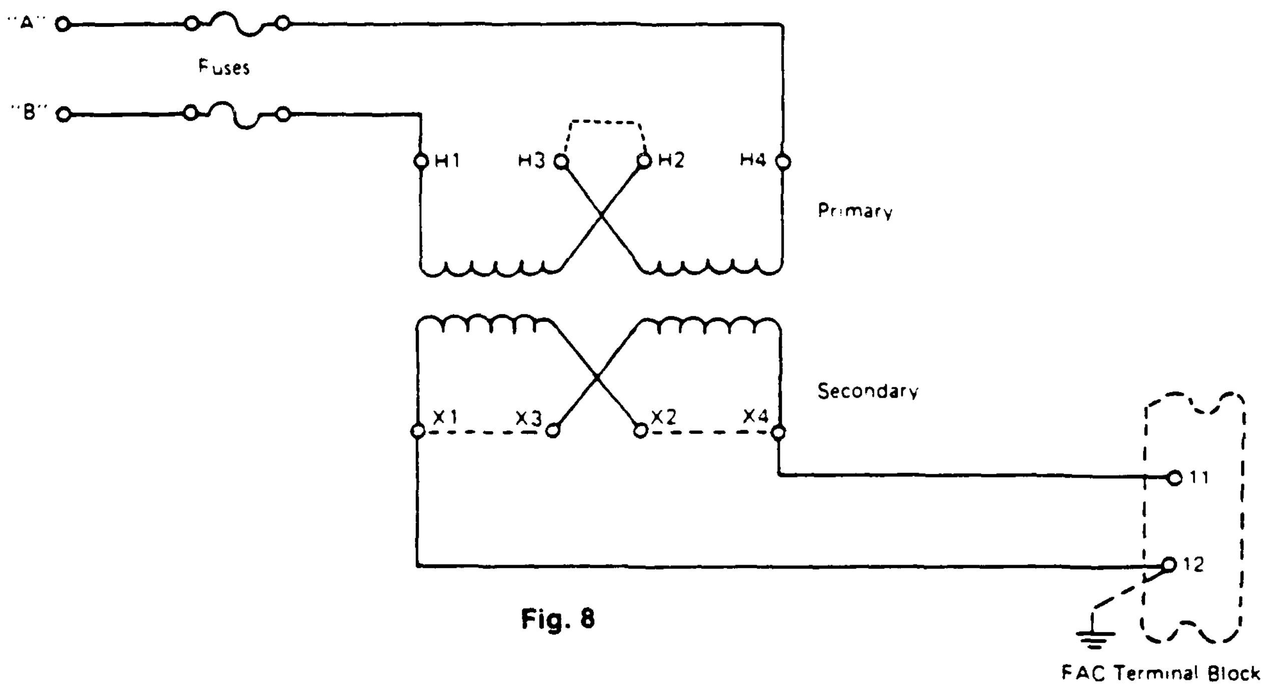


Fig. 8

Notes

1. Points A and B connected to 240 or 480 volt supply
2. Fuses — see table below
3. Connect primary of CPT for correct input voltage See CPT nameplate for proper connection
4. Connect secondary of CPT as shown by dotted lines
5. Output of CPT connected to terminal points 11 and 12 of FAC panel See Fig 7

Main Transformer	Input Voltage to CPT	Fuse Size Required
Up to 3000 KVA	240V 480 V	250V · 9A 600V · 5A
Above 3000 KVA	480V	600V 9A

Table 3

NOTES

Cimco Series 50XL
Winding Temperature Indicator & Controller for Dry-Type Transformers

Cimco Electronics, Inc.
P.O. BOX 240 • 104 MAIN ST.
West Middlesex, PA 16159
(412) 528-8559

Cimco's Series 50 XL instruments provide hot spot temperature measurement, fan on-off control, alarm indication, audio alarm, trip indication, and trip and alarm switches for dry-type transformers. These instruments will also measure and remember the maximum temperature that is experienced by the three transformer coils.

OPERATION

As the temperature of the transformer hot spot changes, the ambient compensated circuit provides accurate indication of the highest temperature which the 3 thermocouples sense. This highest temperature is used to drive the control logic. The set points for the switch and light operation are energized from the same circuit which drives the indicator on the face of the panel. The alarm and trip relays have a 5°C hysteresis to maintain alarm and trip information. The fan control has a 25°C hysteresis to help extend the life of the fans and the fan relay contacts. The power light is green, the fans-on light is yellow, the alarm light is red, and the trip light is red.

THERMOCOUPLES

These instruments use Type "E" thermocouples. Type "E" thermocouples are used to reduce the introduction of errors that can occur if thermocouples are used that contain magnetic materials. The specially constructed Cimco thermocouples can be imbedded into the 1.2 KV dry-type coils to sense the hot-spot temperature directly without concern for thermal gradients within the coils.

FAIL SAFE FEATURES

- With loss of power, Alarm turns on
- With loss of any thermocouple, Alarm and Fan relays turn on while the trip circuit does not turn on under either of the above conditions.
- If fan control switch is in off position or if fan control logic is inoperative, the trip function will turn on fans.

INSTALLATION

- Complete instructions are printed on the back side of the instrument next to the terminals.
- All relays are included in the instrument.
- 120 / 240 VAC input power selection
- Panel mounted
- One piece installation
- Verify accuracy by reading ambient at start.
- Set points are adjustable by transformer manufacturer
- Verify set points with self-test feature
- Use Type "E" thermocouples
- The red thermocouple lead is "negative".

CONSTRUCTION

All of the necessary circuitry and relays are enclosed. An attractive face plate covers the small cabinet and is used to mount the instrument in the dry-type transformer sheet metal enclosure. All connecting terminal points are located on the back of the instrument and are clearly labeled to help reduce error during installation.

AUGUST 1989

Cimco Electronics, Inc.
P.O. BOX 248 • 104 MAIN ST.
West Middlesex, PA 16159
(412) 528-8559

OPERATIONAL CONTROLS

• FAN CONTROL SWITCH

The fan control switch can be in the automatic, manual, or off position. In automatic, fans turn on and off at the previously set fans on-and-off temperature. In the manual position, fans will be turned on at all times. In the off position, fan power is not available to the fans.

• ALARM

The operator can silence the local **alarm** located on the front panel of the instrument. The remote alarm continues until the alarm condition clears. The complete alarm circuit is tested by using the self test feature.

• SELF TEST

The **self test** feature provides the operator with the ability to test all set points without the need for additional instrumentation. The push and hold control energizes the test circuit. The make and break set points are checked by changing the turn to check control and comparing the on-off action of the fans on, alarm, and trip lights with the indication on the read-out. The fans, local and remote alarms, and trip lights are turned on by the self test feature. The trip relay is not energized during self test.

The self test feature can also be used to change the set points. **Contact the transformer manufacturer before attempting to change set-points.** The set-points are established to protect the insulation system as well as the electrical operating system.

The self test feature can also be used to test the entire electrical control scheme and fans. The trip circuit will not energize when using the self test feature.

• MAXIMUM TEMPERATURE MEMORY

The **maximum temperature memory** is displayed on the meter by pressing the push to read control. The maximum memory is erased by pressing the push to reset control. The maximum temperature memory is retained in the electronics for 30 days or more if the power to the instrument is lost. A battery is not used to retain memory.

• THREE THERMOCOUPLE SELECTOR

The **three thermocouple selector** feature operates automatically to select the hottest phase to be used in the control logic. To read the temperature of the other phases, press the corresponding control button. Three lights indicate which phase is the hottest and is being used in the control logic.

• FUSE

The front mounted fuse or breaker is to protect the fans. The instrument is not fused in order to provide maximum protection for the transformer.

Cimco Series 58XL

Winding Temperature Indicator & Controller for Dry-Type Transformers

Cimco Electronics, Inc.
P.O. BOX 248 • 104 MAIN ST.
West Middlesex, PA 16159
(412) 528-8559

FEATURES

- **SELF-TEST**
  - ALL ON-OFF SET-POINTS CAN BE CHECKED BY USING FRONT PANEL CONTROLS.
  - ALL O SET-POINTS CAN BE CHANGED USING THE FRONT PANEL CONTROLS AND THE SCREW DRIVER ADJUSTMENTS. (DEAD BAND IS FIXED)
  - MAXIMUM MEMORY IS NOT AFFECTED BY SELF-TEST
  - EXTERNAL TRIP CIRCUIT IS NOT AFFECTED
  - LOCAL ALARM CAN BE TESTED
  - FANS AND REMOTE ALARM CAN BE TESTED
  - FANS ON, ALARM, AND TRIP LIGHTS CAN BE TESTED
- **FAIL-SAFE**
  - FOR ANY OPEN THERMOCOUPLE
    - METER WILL READ FULL SCALE
    - MAXIMUM MEMORY READS FULL SCALE
    - FAN, ALARM, AND TRIP LIGHTS TURN ON
    - ALARM RELAYS OPERATE
    - LOCAL SONIC ALARM OPERATES
    - TRIP RELAY DOES NOT OPERATE
  - FOR LOSS OF POWER TO INSTRUMENT
    - ALL LIGHTS TURN OFF
    - ALARM RELAYS TURN ON
    - MAXIMUM TEMPERATURE IS STORED
      - RETAINED AT LEAST FOR 30 DAYS
      - NO LOSS OF ACCURACY
      - NO BATTERY POWER
- **INSTALLATION INSTRUCTIONS**
  - COMPLETE INSTRUCTIONS ON BACK PLATE
  - TERMINALS CLEARLY MARKED
  - FUNCTIONAL DESCRIPTION INCLUDED
  - THERMOCOUPLE CONNECTING INSTRUCTIONS
  - 120 / 240 VAC INPUT SELECTION
  - 30 AMPS OF FAN POWER
  - TWO SETS OF FAN POWER TERMINALS
- **OPERATING INSTRUCTIONS**
  - SINGLE FUNCTION CONTROLS -- ALL OF THE FRONT PANEL CONTROLS PERFORM ONE FUNCTION ONLY.
  - INSTRUCTIONS FOR EACH CONTROL ARE PRINTED ON THE FRONT PANEL NEXT TO THE CONTROL.
  - EXPERIENCED CONTROL ROOM OPERATORS USUALLY DO NOT REQUIRE ANY TRAINING TO OPERATE THIS INSTRUMENT.

OPERATING INSTRUCTIONS FOR MAXIMUM TEMPERATURE MEMORY

- AT START-UP
  - PRESS "PUSH TO READ"
  - PRESS "PUSH TO RESET" IF RESET IS DESIRED
  - NORMAL OPERATION
  - PRESS "PUSH TO READ" TO DETERMINE MAXIMUM TEMPERATURE SINCE LAST RESET
  - PRESS "PUSH TO RESET" TO CLEAR THE MAXIMUM TEMPERATURE VALUE IN MEMORY

OPERATING INSTRUCTIONS FOR SELF-TEST FEATURE

- SET FAN MODE CONTROL TO AUTOMATIC
- ROTATE SELF-TEST CONTROL COUNTER-CLOCK WISE
- PRESS "PUSH AND HOLD" SWITCH
- SLOWLY ROTATE SELF-TEST CONTROL CLOCK WISE
- RECORD THE TEMPERATURE INDICATION ON THE METER AS EACH OF THE CONTROL LIGHTS TURNS ON.
- SLOWLY ROTATE THE SELF-TEST CONTROL COUNTER CLOCKWISE. (OK TO SILENCE ALARM DURING CHECK)
- RECORD THE TEMPERATURE INDICATION ON THE METER AS EACH OF THE CONTROL LIGHTS TURNS OFF

C-41

AUGUST 1989

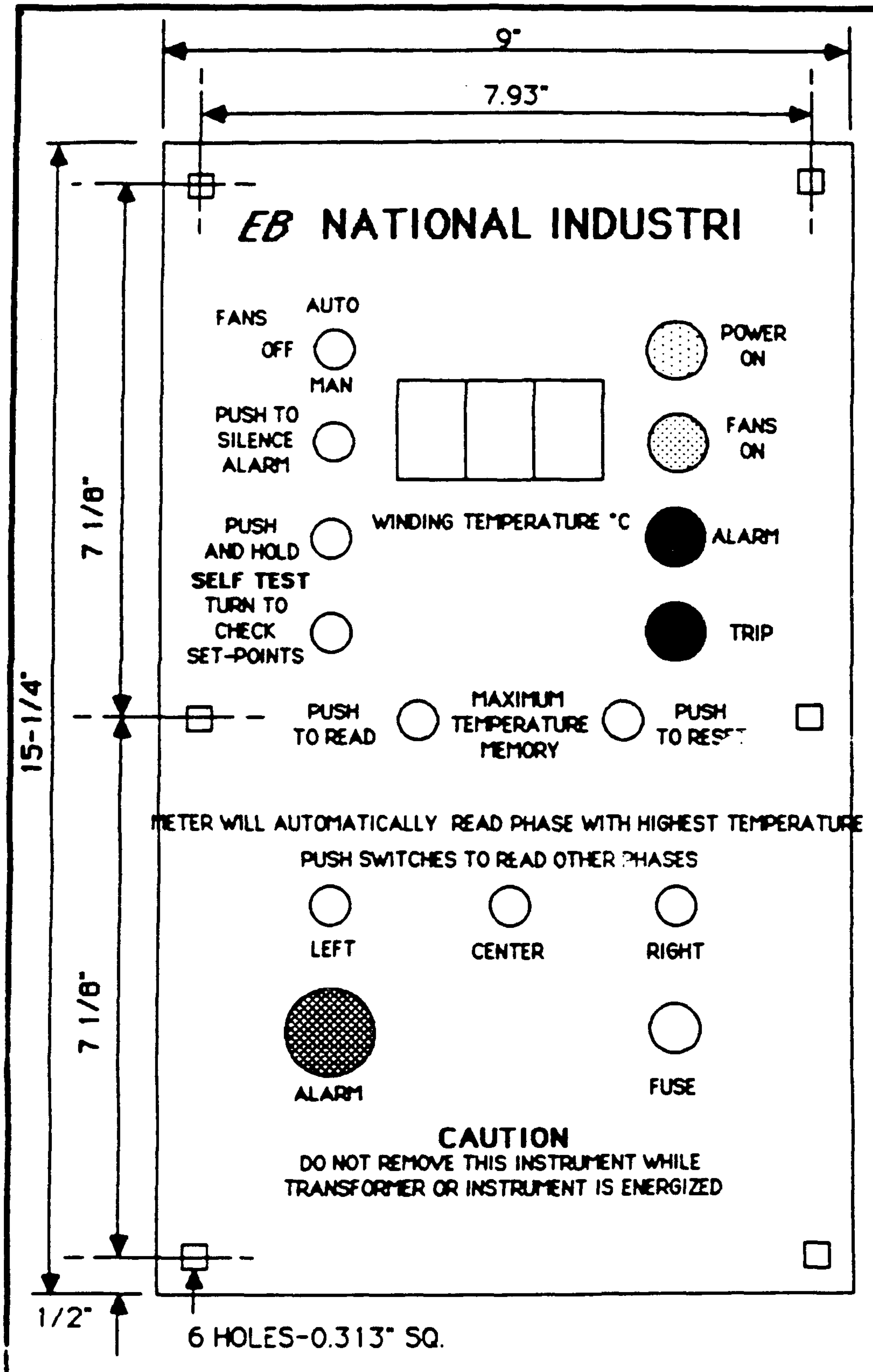
Cimco Series 58XL
Winding Temperature Indicator & Controller for Dry-Type Transformers

Cimco Electronics, Inc.
P.O. BOX 248 • 104 MAIN ST.
West Middlesex, PA 16159
(412) 528-8558

GENERAL SPECIFICATIONS

FEATURE	STANDARD	OPTIONAL
SCALE RANGE	0-250°C	
SCALE TYPE	DIGITAL	
ACCURACY	± 1 % OF FULL SCALE	
CURRENT LOOP		4-20 MILLI AMP
SET POINT RANGE	FULL SCALE	
DEAD BAND		
FANS	25°C	>10°C<50°C
ALARM AND TRIP	5°C	>5°C<20°C
FAN CONTROL	AUTO-OFF-MANUAL	AUTO-MANUAL
FAN RELAY RATINGS		
FANS 1 (SPST)	1 HP AT 120 VAC 1-1/2 HP AT 240 VAC	
FANS 2 (SPST)	1 HP AT 120 VAC 1-1/2 HP AT 240 VAC	
ALARM AND TRIP RELAY RATING	10 AMPS AT 120 VAC 8 AMPS AT 240 VAC AT PF = 1.0 1.5 AMPS AT 125 VDC 0.7 AMPS AT 240 VDC	
THERMOCOUPLE	TYPE "E" 3 REQUIRED	
SUPPLY POWER	120 OR 240 VAC	
MAXIMUM LOAD	30 AMPS	
PROTECTION	20 AMP FUSE	SINGLE POLE BREAKER ON FAN CIRCUIT
SONIC ALARM	FRONT PANEL MOUNT 90db - INTERMITTENT SIREN	
PANEL CUT-OUT	6.75" WIDE BY 13.875"	CONTACT CIMCO
HI-POT TEST*	1500 VAC, 60HZ, 60 SEC.	

*TEST NOTES
- DURING HI-POT TEST; DO NOT INCLUDE THE THERMOCOUPLE TERMINALS IN THE TEST.
- DURING IMPULSE TEST; DO NOT CONNECT THERMOCOUPLE TERMINALS TO GROUND.



NOTES

1. FACE PLATE IS 0.60" BRUSHED ALUMINUM.
2. LETTERING IS SLIGHTL SMALLER IN SCALE TH THAN SHOWN.
3. BOX IS 4" DEEP.
4. BOX IS 6-1/2" X 11-1
5. TYPE "E" THERMOCOUF IS STANDARD.
6. FUSE DOES NOT INTERRUPT POWER TC INSTRUMENT.
7. ALARM EMITS AN INTERMITTENT HIGH PITCHED SIREN TYPE OF SOUND RATED AT 90 db.
8. ALL LIGHTS ARE LED'S
9. DIGITAL METER IS LEC

SERIES 50 XL
NATIONAL INDUSTI

CIMCO ELECTRONICS, INC
WEST MIDDLESEX, PA 161
(412) 528-9559

SUB 1 1-10-89	SCALE = 1/2	DEC. 3,1

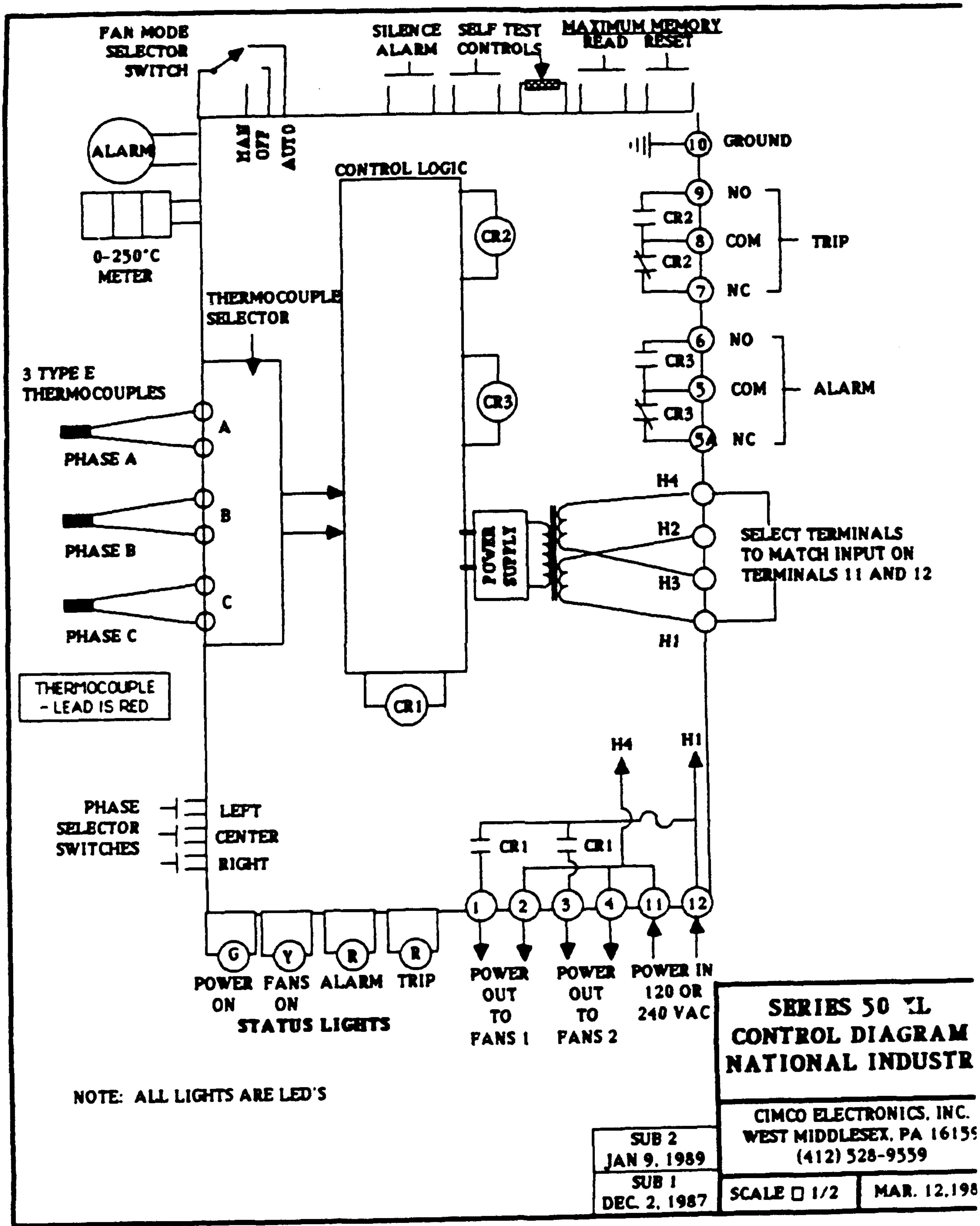

FAN MODE SELECTOR SWITCH
MAN
OFF
AUTO
SILENCE ALARM
SELF TEST CONTROLS
MAXIMUM MEMORY
READ
RESET
ALARM
0-250°C METER
CONTROL LOGIC
GROUND
NO
COM
NC
TRIP
CR2
CR3
ALARM
THERMOCOUPLE SELECTOR
3 TYPE E THERMOCOUPLES
A
B
C
PHASE A
PHASE B
PHASE C
POWER SUPPLY
H4
H2
H3
H1
SELECT TERMINALS TO MATCH INPUT ON TERMINALS 11 AND 12
THERMOCOUPLE - LEAD IS RED
CR1
PHASE SELECTOR SWITCHES
LEFT
CENTER
RIGHT
G
Y
R
POWER ON
FANS ON
ALARM
TRIP
STATUS LIGHTS
POWER OUT TO FANS 1
POWER OUT TO FANS 2
POWER IN 120 OR 240 VAC
SERIES 50 XL
CONTROL DIAGRAM
NATIONAL INDUSTR
NOTE: ALL LIGHTS ARE LED'S
CIMCO ELECTRONICS, INC.
WEST MIDDLESEX, PA 1615
(412) 528-9559
SUB 2
JAN 9, 1989
SUB 1
DEC. 2, 1987
SCALE □ 1/2
MAR. 12,198

ABB
ASEA BROWN BOVERI

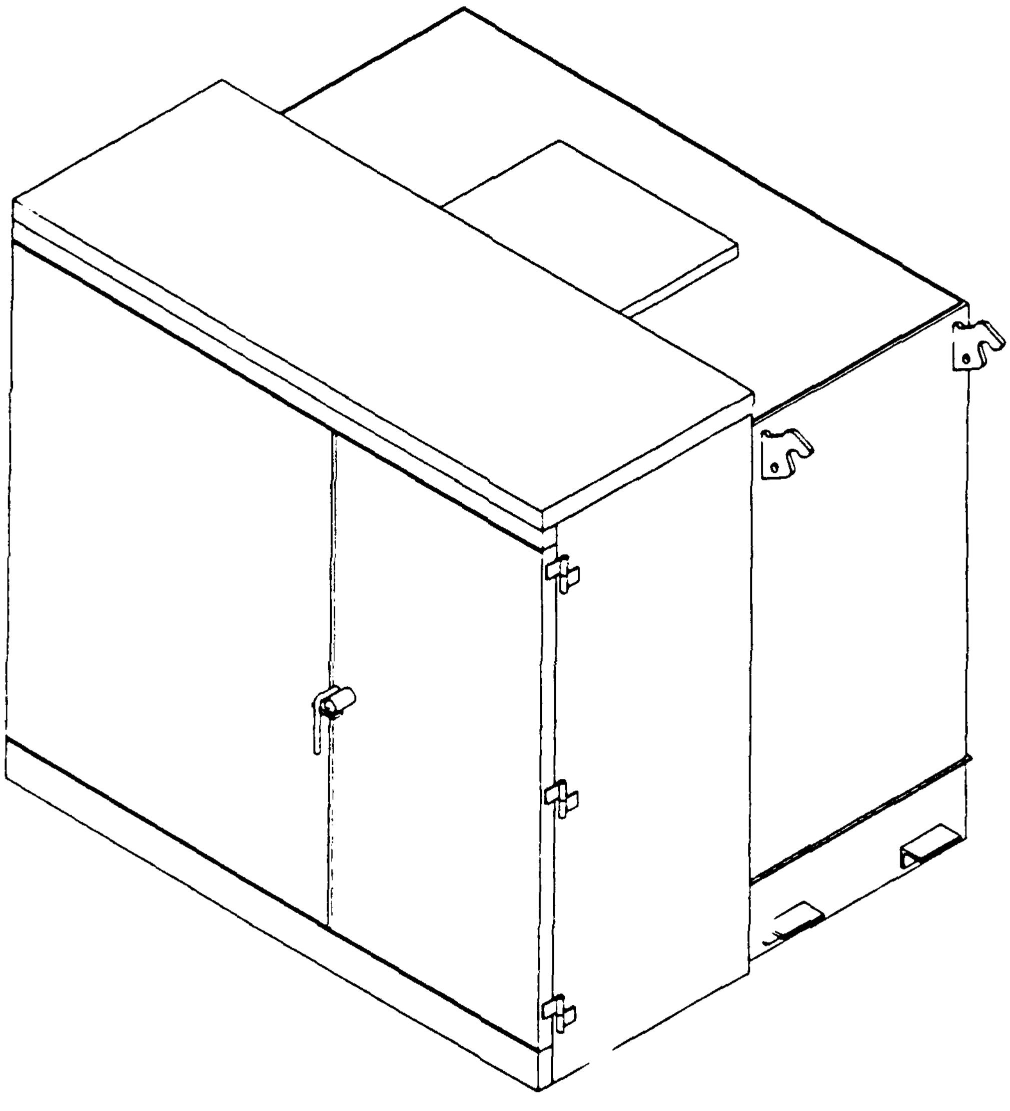
ABB Power T&D Company Inc.
Underground Distribution Transformers
Jefferson City, MO 65101

Instruction Booklet
I.B. 46-060-1, Section D

Effective May 1991
Supersedes I.B. 46-060-1, Section D, dated June, 1985

Instructions for Oil-Immersed Distribution Transformers

Section D: Padmounted, 75-2500 KVA, **Three-Phase**



1.0 INTRODUCTION

The three phase padmounted distribution transformer is designed to provide electrical service on underground distribution systems. The transformer is designed for outdoor mounting on a pad. Primary and secondary cables enter the transformer compartment from below through openings in the pad. All exposed live parts are completely enclosed in tamper-resistant cabinets with provisions for padlocking.

The transformers described herein are designed for the conditions normally encountered on electric utility power distribution systems. As such they are suitable for use under the "usual service conditions" described in ANSI C57.12.00 (General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers. All other conditions are considered unusual service and should be avoided.

2.0 SAFETY

WARNING: READ THIS INSTRUCTION BOOK CAREFULLY BEFORE ATTEMPTING TO INSTALL, MAINTAIN, OPERATE OR SERVICE THE TRANSFORMER. FAILURE TO FOLLOW INSTRUCTIONS CAN CAUSE SEVERE INJURY, DEATH, OR PROPERTY DAMAGE.

Keep this Instruction Book available to those responsible for the installation, maintenance, operation, and service of the transformer. Safety as defined in this Instruction Book involves two conditions:

1. Personal injury
2. Product or property damage

SEE IMPORTANT "DISCLAIMER OF WARRANTIES AND LIMITATION OF LIABILITY" ON PAGE 12.

Safety notations intended to alert personnel of possible personal injury, death or property damage, have been inserted in the instructional text prior to the step in which the condition is cited. These safety notations are headed by one of three hazard intensity levels which are defined as follows:

[illegible]

2. *WARNING* — Hazard or unsafe practice which can cause severe personal injury, death or substantial property damage.

3. *CAUTION* — Hazard or unsafe practice which will or can cause minor personal injury or minor property damage.

The transformer should be operated and serviced only by competent personnel familiar with good safety practices. These instructions are written for such personnel and are not intended as a substitute for adequate training and experience in the use of this equipment. Should clarification or further information be required or should problems arise which are not covered sufficiently for the user's purpose, refer the matter to the ABB Power T&D Company Inc. When communicating with ABB regarding the product covered by this Instruction Book, always include the following items of information from the transformer's nameplate: Serial number, style number, KVA rating, high voltage and low voltage ratings.

Additionally, all applicable safety procedures such as OSHA requirements, regional and local safety requirements, safe working practices and good judgement must be used by such personnel.

3.0 RECEIVING

WARNING: DO NOT LIFT THE TRANSFORMER BY USING CRANES OR JACKS ON ANY PART OF THE TRANSFORMER OTHER THAN THE LIFTING HOOKS OR JACKING PADS PROVIDED FOR THIS PURPOSE. IMPROPER LIFTING OR JACKING CAN CAUSE SEVERE INJURY AND PROPERTY DAMAGE.

The transformers are normally shipped completely assembled and ready to install. Each transformer should be carefully inspected upon receipt and the transportation company notified of any damage that has been incurred. The shipping list should be checked for possible shortages.

Three-phase transformers are normally shipped on a pallet. Palletized transformers in these ratings may be moved readily by a lift truck, crane, or cart. The lifting hooks supplied on the sides of the transformer enable it to be lifted by crane.

Be sure the device chosen has the capacity to lift, or move, the complete unit. (Weight is shown on the nameplate.)

Lift the transformer utilizing all the hooks and use proper spreaders to obtain a vertical lift.

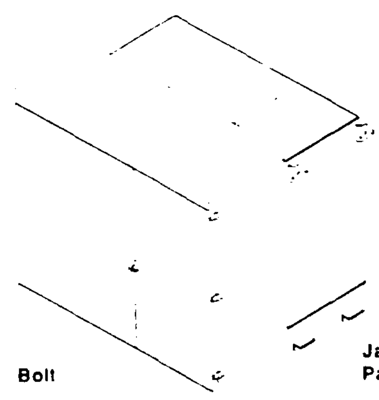


Fig. 1

This transformer has been furnished with a "penta-head" locking bolt that must be loosened to open the compartment. This bolt can be turned with a standard pentahead socket (wrench), as used widely in the utility industry. Sockets can be obtained from the Snap-On Company (tool #B2191), or equivalent.

4.0 EXTERNAL INSPECTION

WARNING: THE OIL MUST BE AT THE PROPER LEVEL BEFORE VOLTAGE IS APPLIED TO THE TRANSFORMER. FAILURE TO MAINTAIN THE PROPER OIL LEVEL CAN CAUSE SEVERE PERSONAL INJURY, DEATH OR SUBSTANTIAL PROPERTY DAMAGE.

The oil level should be checked by removing the oil level plug located at the 25 °C level. Any unit which does not have the proper oil level should be checked for leaks and refilled through the vent plug before placing in service. Use only quality oil per ASTM D3487 when adding oil to the transformer. The transformer was filled or processed at the factory with non-PCB dielectric fluid in accordance with Federal Polychlorinated Bi-phenyl (PCB) Regulations 40 CFR 761, et seq. The non-PCB fluid contained less than 1ppm at time of processing or filling. The owner should take the necessary precautions so that PCB contamination is not introduced during field filling or maintenance of the transformer (refer to Fig. 2)

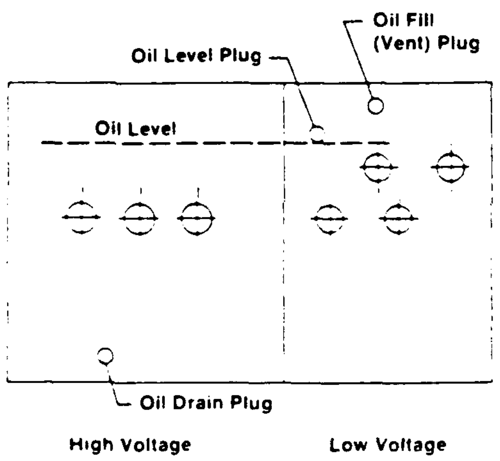


Fig. 2

5.0 INTERNAL TANK INSPECTION

WARNING: ALWAYS VENT THE TRANSFORMER BY FOLLOWING THE INSTRUCTIONS IN SECTION 7.3. FAILURE TO DO SO CAN CAUSE SEVERE PERSONAL INJURY, DEATH OR SUBSTANTIAL PROPERTY DAMAGE.

CAUTION: WHEN A TRANSFORMER IS OPENED, USE CARE TO PREVENT ENTRANCE OF MOISTURE OR FOREIGN OBJECTS. MOISTURE, DIRT OR FOREIGN OBJECTS CAN WEAKEN THE INSULATION OF A TRANSFORMER AND GREATLY SHORTEN ITS LIFE.

The transformer covered by this instruction is shipped ready for installation and does not require internal inspection. However, if the transformer must be opened, prevent the entrance of moisture or other foreign material.

6.0 STORAGE

The transformer should be stored completely assembled (tank sealed and cabinetry closed) as though it were energized and at its permanent location. Transformers should not be stacked on top of one another, and care must be exercised to prevent submersion in water. The transformer should be stored on a solid, level foundation.

In the event a transformer is to be held in storage for a period in excess of one (1) year, it is recommended the space above the oil be pressurized with dry air to two (2) to three (3) psig. This will prevent moisture ingress due to negative pressure.

The transformer will be ready for service at any time provided it has received the inspections outlined in Sections 4.0 and Section 7.0 thru 7.7.

7.0 INSTALLATION

Installation should comply with the latest edition of the National Electrical Code.

7.1 Mounting

WARNING: FAILURE TO PROPERLY MOUNT THE TRANSFORMER CAN CAUSE SEVERE INJURY, DEATH OR PROPERTY DAMAGE.

The transformers should be mounted on a flat level pad strong enough to support the weight of the transformer. The unit should not be tilted in any direction greater than 1.5 degrees, as a greater tilt *will cause deviations in liquid level* near fuses, pressure relief devices, or other accessories specifically located at or near the 25 degree C liquid level.

CAUTION: DEVIATIONS IN OIL LEVEL CAN INCREASE THE POSSIBILITY OF A DISRUPTIVE FAILURE.

When supplied, hold down cleats or brackets should be used to bolt the transformer securely to the pad (refer to Fig. 3)

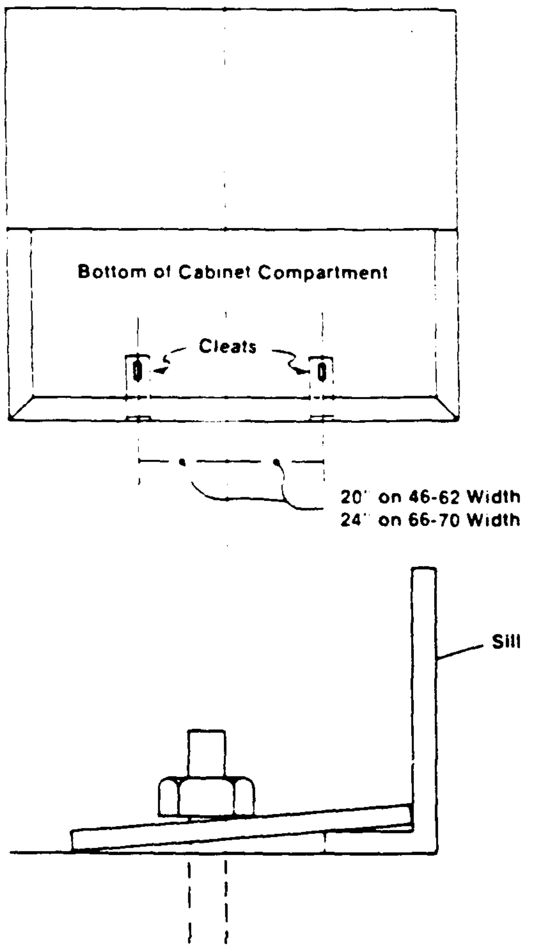
The transformer cabinet should sit flush on the pad allowing no gaps which would compromise the tamper-resistance of the transformer.

7.2 Location

Since these transformers contain a flammable insulating fluid (mineral oil), transformer failure can cause fire and or explosion. This possibility should be considered when locating these transformers in close proximity to buildings or public thoroughfares. Refer to the latest edition of the National Electrical Code.

7.3 Venting

Vent the transformer by manually operating the pressure relief device normally provided, or by removing the vent plug. The transformer should be vented before it is energized if it has been pressurized for leak test or if the unit has been opened and resealed.



Typical Bolted Cleat Assembly

Fig. 3

7.4 Grounding

WARNING: THE TRANSFORMER MUST BE PROPERLY GROUNDED PRIOR TO ENERGIZING. FAILURE TO PROPERLY GROUND CAN CAUSE SEVERE INJURY OR DEATH.

A good permanent low impedance ground connection must be made to the tank by using the ground pads provided near the bottom of the tank for this purpose.

Transformers which are designed for use on a grounded wye system, that is, one having a solidly grounded neutral, must have the tank and other available neutrals permanently and solidly grounded to the common neutral of the system before the transformer is energized.

7.5 Connections

During installation the recommended sequence of connections is to first make all ground connections, then the low voltage connections, and finally the high voltage connections. The transformer should be removed from service by reversing the above sequence of connections. Carefully check the transformer nameplate for its rating and the connections that can be made to it. Avoid excessive strain on the bushing terminals or insulators. This could loosen the contact joints or damage the insulators.

7.6 Liquid Level

WARNING: ENERGIZATION OR OPERATION OF THE TRANSFORMER WITH THE INSULATING LIQUID LOWER THAN ½ INCH BELOW THE 25°C LEVEL (½ INCH BELOW THE BOTTOM EDGE OF THE LIQUID LEVEL PLUG) CAN CAUSE SEVERE INJURY, DEATH, OR PROPERTY DAMAGE.

Never operate or apply voltage to transformer if the liquid level is below the 25 degree C liquid level plug more than ½ inch. Check the liquid level *before* the transformer is energized to ensure the proper liquid level.

NOTE: Cold temperatures can cause the liquid level to drop, through contraction, by more than ½ inch. When this happens, the liquid should be heated to allow for expansion to the proper liquid level or additional liquid is to be added to bring the liquid level up to within ½ inch of the liquid level plug. This liquid will then have to be removed when the unit has reached normal operating temperature. Follow the maintenance information in Section 10.0 when adding and removing any liquid.

7.7 Cabinet Security

WARNING: FAILURE TO PROPERLY SECURE THE CABINET MAY ALLOW ACCESS BY UNAUTHORIZED PERSONNEL WHICH CAN CAUSE SEVERE INJURY, DEATH, OR PROPERTY DAMAGE.

Before leaving the site of an energized transformer, make sure that any protective or insulating barriers are in place, the cabinet is completely closed, and all locking provisions are properly installed.

The following procedure should be used to assure cabinet security.

A. Close the high voltage (left) door and secure it in place with the captive bolts supplied (pentahead or hexhead).

B. Close the low voltage (right) door and secure it in place by rotating the handle in a clockwise direction until seated (handle should then be in a vertical orientation).

C. Tighten the safety bolt (pentahead or hexhead) located in the locking tube until fully seated.

D. Install a padlock through the door handle and locking tube and secure.

E. Check both the high and low voltage doors for proper fit and security.

8.0 OPERATION

This transformer was built and tested in accordance with the latest version of the following standards of American National Standards Institute.

ANSI C57.12.00 — General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers.

ANSI C57.12.90 — Test Code for Liquid-Immersed Distribution, Power and Regulating Transformers and Guide for Short-Circuit Testing of Distribution and Power Transformers.

The pad-mounted transformer is an integral part of the distribution system and consideration must be given to proper protection from system disturbances. Protection from excessive voltage transients and severe overcurrents should be provided. To allow proper operation of overcurrent devices that may be supplied with the transformer, coordination with system overcurrent protection must be achieved.

9.0 ACCESSORIES AND COMPONENTS

9.1 Bushings

CAUTION: **REMOVE ALL DIRT AND FOREIGN MATERIAL FROM ALL BUSHINGS BEFORE PLACING TRANSFORMER IN SERVICE. READ AND FOLLOW THE MANUFACTURER'S INSTRUCTIONS FOR INSTALLING SEPARABLE-INSULATED HIGH VOLTAGE CONNECTORS. DO NOT ENERGIZE THE TRANSFORMER WITH THE SHIPPING CAPS ON THE BUSHINGS OR INSERTS. DO NOT OPERATE THE TRANSFORMER BEYOND THE MANUFACTURER'S RATING. FAILURE TO DO SO CAN CAUSE MINOR PERSONAL INJURY OR PROPERTY DAMAGE.**

9.1.1 Separable Insulated Connectors

Separable insulated connectors may be universal bushing wells, integral bushings or bushing wells with inserts installed. They may be either loadbreak or non-loadbreak. All connectors must be dry and clear of any contamination before installation. Unused terminals should be properly terminated to prevent possible contamination. Follow the manufacturer's instructions and warnings on the use of these terminations.

9.1.2 Porcelain Bushings

High voltage porcelain bushings (when provided) are externally clamped, gasketed bushings with eyebolt-type terminals. The primary cables enter the compartment from below and attach to the bushing terminals. The eyebolt-type terminals will accommodate No. 6 through 250 kcmil cable.

9.2 Fuses

WARNING: **OPERATION OF A FUSE MAY INDICATE A FAULTED TRANSFORMER. DO NOT REPLACE THE FUSE UNLESS THE CAUSE OF THE FUSE OPERATION IS POSITIVELY IDENTIFIED AND CORRECTED. IF THE CAUSE OF THE FUSE OPERATION CANNOT BE POSITIVELY IDENTIFIED AND CORRECTED, THE TRANSFORMER SHOULD BE REPLACED OR RE-ENERGIZED FROM A REMOTE LOCATION. FAILURE TO DO SO CAN CAUSE SEVERE INJURY, DEATH OR PROPERTY DAMAGE.**

WARNING: **FUSES SHOULD BE OPERATED WITHIN THEIR RATINGS AND REPLACED WITH FUSES HAVING EQUIVALENT VOLTAGE AND TIME-CURRENT CHARACTERISTICS. FAILURE TO DO SO CAN CAUSE SEVERE INJURY, DEATH OR PROPERTY DAMAGE.**

9.2.1 Protective Link

[illegible]

WARNING: **VENT THE TRANSFORMER BEFORE DISTURBING THE TANK SEAL. FAILURE TO DO SO CAN CAUSE SEVERE INJURY, DEATH OR PROPERTY DAMAGE.**

The protective link is an oil-immersed high voltage expulsion fuse designed to isolate the transformer from the distribution system in the event of a transformer fault inside the tank on the load side of the link. It is not designed to provide overload or secondary fault current protection for the transformer.

When inspecting or replacing protective links, always vent the transformer before disturbing the tank seal as outlined in section 7.3. Care should be taken to prevent the entrance of moisture or foreign material.

For further technical information, refer to ABB TPL 44-835.

9.2.2 Bayonet Oil Fuse

WARNING: **VENT THE TRANSFORMER BEFORE OPERATING THE BAYONET FUSEHOLDER. FAILURE TO DO SO CAN CAUSE SEVERE INJURY, DEATH OR PROPERTY DAMAGE.**

The bayonet oil fuse is a device which permits replacement of an under-oil expulsion fuse in the field and has loadbreak capability allowing it to energize and de-energize a transformer.

To operate or replace the fuse, follow the instructions in Fig. 4.

For further technical information, refer to ABB TPL 44-835.

9.2.3 Loadbreak Drawout Fuseholder

This device combines the high interrupting capability of a general purpose current-limiting fuse with a dry-well fuseholder. The loadbreak drawout utilizes the rod and bore principle to accomplish loadbreak and loadmake within the fuseholder.

To operate or replace the fuse, follow the instructions shown in Figs. 5 and 6.

For further technical information, refer to ABB TPL 44-837.

9.2.4 Deadbreak Drawout Fuseholder

DANGER: DE-ENERGIZE THE TRANSFORMER BEFORE REMOVING OR INSTALLING THE DEADBREAK DRAWOUT FUSEHOLDER ASSEMBLY. FAILURE TO DO SO WILL RESULT IN SEVERE INJURY, DEATH OR PROPERTY DAMAGE.

Text Continued on Page 8

To operate the bayonet Loadbreak Fuseholders it is necessary to raise the Hinged Weathercover (Flip-top).

With both cabinet doors fully open (over 90 degrees), push upward on the front edge of the cover assembly. Tilt the hinged cover backward until the supporting arm connected to the high-low barrier, can be securely latched in place on the inside of the cover.

Proceed with the operating instructions for the Bayonet Loadbreak Fuseholder (below).

BAYONET LOADBREAK FUSEHOLDER

WARNING: OPERATE THE FUSEHOLDER PER THESE INSTRUCTIONS. FAILURE TO DO SO CAN RESULT IN SEVERE INJURY, DEATH OR PROPERTY DAMAGE.

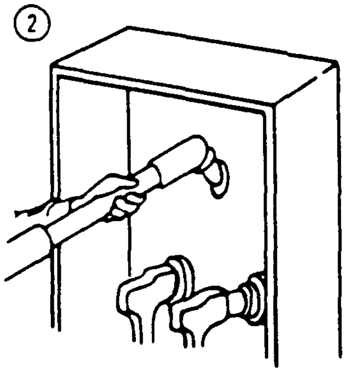
OPERATING INSTRUCTIONS

(1)

WARNING: VENT THE TRANSFORMER BEFORE OPERATING THE BAYONET FUSE HOLDER. FAILURE TO DO SO CAN CAUSE SEVERE INJURY, DEATH OR PROPERTY DAMAGE.

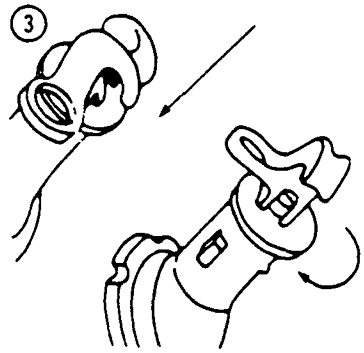
VENT THE TRANSFORMER AS OUTLINED IN SECTION 7.3

(2)



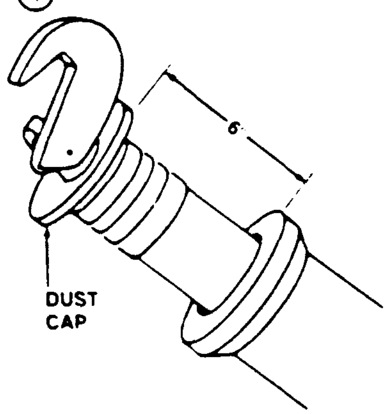
ATTACH HOT-LINE TOOL TO HANDLE EYE. STAND TO ONE SIDE AND UNLOCK THE HANDLE.

(3)



PUSH DOWN AND ROTATE THE HANDLE 90° CLOCKWISE IN THE HOUSING TO BREAK ANY ADHESION BETWEEN THE GASKET AND THE HOUSING.

(4)



JERK THE FUSEHOLDER OUT APPROXIMATELY 6" TO OPEN THE CIRCUIT. WAIT A FEW SECONDS FOR OIL TO DRAIN BACK INTO THE TANK. THEN COMPLETELY WITHDRAW FUSEHOLDER.

(5)

TO REPLACE FUSE:

INSTRUCTIONS FOR REPLACING FUSE ELEMENT ARE PACKED WITH EACH REPLACEMENT FUSE. FOLLOW THE FUSE MANUFACTURER'S INSTRUCTIONS.

(6)

TO REINSTALL FUSEHOLDER:

ATTACH HOT-LINE TOOL TO HANDLE EYE. STAND TO ONE SIDE AND PLACE THE FUSEHOLDER END JUST INSIDE THE HOUSING.

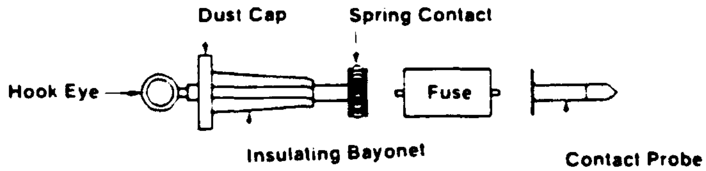
RAPIDLY PUSH THE FUSEHOLDER IN UNTIL DUST CAP SEATS AGAINST HOUSING.

PUSH DOWN AND ROTATE THE LOCKING HANDLE HOOKING IT OVER THE SHOULDER OF THE HOUSING.

When the bayonet operations are completed, release the latch on the Hinged Weathercover by tilting the cover slightly backwards. Lower the cover, making sure it is all the way down. (The upper high-voltage door bolt should engage THROUGH the hole in the Hinged Weathercover.)

Fig.4

CLT TYPE LOADBREAK DRAWOUT FUSEHOLDER



WARNING: ASSEMBLE AND OPERATE FUSEHOLDER PER THESE INSTRUCTIONS. FAILURE TO DO SO CAN RESULT IN SEVERE INJURY, DEATH OR PROPERTY DAMAGE.

OPERATING INSTRUCTIONS

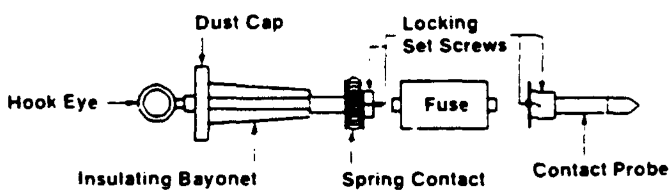
LOADBREAK ATTACH HOT-LINE TOOL TO HOOK EYE RAPIDLY WITHDRAW FUSEHOLDER ASSEMBLY COMPLETELY FROM HOUSING

LOADMAKE ATTACH HOT-LINE TOOL TO HOOK EYE. INSERT END OF FUSEHOLDER UNTIL CONTACT SPRING HAS JUST ENTERED HOUSING RAPIDLY PUSH ASSEMBLY *STRAIGHT* INTO HOUSING UNTIL DUST CAP SEATS AGAINST HOUSING AND GROUNDING CLIP

TO REPLACE FUSE DISASSEMBLE BY UNSCREWING FUSE FROM INSULATING BAYONET AND CONTACT PROBE REPLACE BLOWN FUSE WITH NEW FUSE OF EQUIVALENT RATING AND CHARACTERISTICS REASSEMBLE BY TIGHTLY SCREWING NEW FUSE ONTO INSULATING BAYONET AND CONTACT PROBE

FIG. 5

NX TYPE LOADBREAK DRAWOUT FUSEHOLDER



WARNING: ASSEMBLE AND OPERATE FUSEHOLDER PER THESE INSTRUCTIONS. FAILURE TO DO SO CAN RESULT IN SEVERE INJURY, DEATH OR PROPERTY DAMAGE.

OPERATING INSTRUCTIONS

LOADBREAK ATTACH HO NE TOOL TO HOOK EYE RAPIDLY WITHDRAW FUSEHOLDER ASSEMBLY COMPLETELY FROM HOUSING

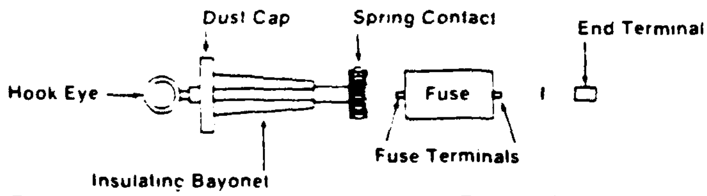
LOADMAKE ATTACH HOT-LINE TOOL TO HOOK EYE. INSERT END OF FUSEHOLDER UNTIL *CONTACT SPRING HAS JUST ENTERED HOUSING* RAPIDLY PUSH ASSEMBLY *STRAIGHT* INTO HOUSING UNTIL DUST CAP SEATS AGAINST HOUSING AND GROUNDING CLIP

TO REPLACE FUSE DISASSEMBLE BY UNSCREWING FUSE FROM INSULATING BAYONET AND CONTACT PROBE REPLACE BLOWN FUSE WITH NEW FUSE OF EQUIVALENT RATING AND CHARACTERISTICS REASSEMBLE BY TIGHTLY SCREWING NEW FUSE ONTO INSULATING BAYONET AND CONTACT PROBE

FIG. 6

CLT TYPE DEADBREAK DRAWOUT FUSEHOLDER

DE-ENERGIZED OPERATION ONLY



DANGER: DE-ENERGIZE THE TRANSFORMER BEFORE REMOVING OR INSTALLING THE DEADBREAK DRAWOUT FUSEHOLDER ASSEMBLY. FAILURE TO DO SO WILL RESULT IN SEVERE INJURY, DEATH OR PROPERTY DAMAGE.

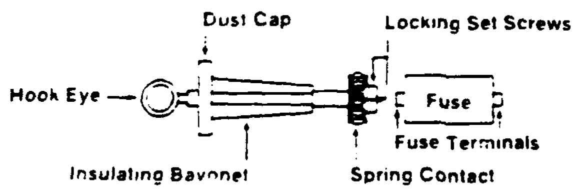
WARNING: **ASSEMBLE AND INSTALL FUSE AND FUSEHOLDER PER THESE INSTRUCTIONS. FAILURE TO DO SO CAN RESULT IN SEVERE INJURY, DEATH OR PROPERTY DAMAGE.**

TO REMOVE FUSE	ATTACH HOT-LINE TOOL TO HOOK EYE AND WITHDRAW FUSEHOLDER STRAIGHT OUT FROM HOUSING
TO REPLACE FUSE	DISASSEMBLE BY UNSCREWING THE FUSE FROM THE INSULATING BAYONET. REPLACE THE BLOWN FUSE WITH A NEW FUSE OF EQUIVALENT RATING AND CHARACTERISTICS. REASSEMBLE BY TIGHTLY SCREWING FUSE ONTO THE INSULATING BAYONET
TO INSTALL FUSE	ATTACH HOT-LINE TOOL TO HOOK EYE AND PLACE FUSEHOLDER INTO HOUSING. PUSH FUSEHOLDER IN FIRMLY UNTIL DUST CAP IS SEATED AGAINST HOUSING AND GROUND CLIP

Fig. 7

NX TYPE DEADBREAK DRAWOUT FUSEHOLDER

DE-ENERGIZED OPERATION ONLY



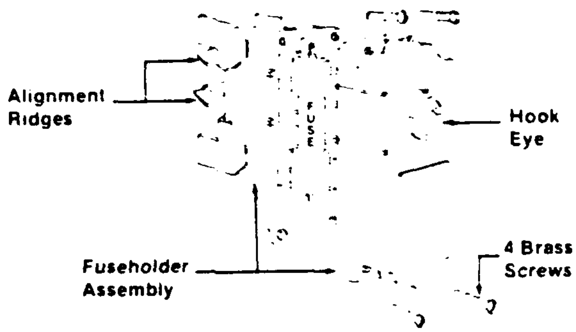
DANGER: DE-ENERGIZE THE TRANSFORMER BEFORE REMOVING OR INSTALLING THE DEADBREAK DRAWOUT FUSEHOLDER ASSEMBLY. FAILURE TO DO SO WILL RESULT IN SEVERE INJURY, DEATH OR PROPERTY DAMAGE.

WARNING: **ASSEMBLE AND INSTALL FUSE AND FUSEHOLDER PER THESE INSTRUCTIONS. FAILURE TO DO SO CAN RESULT IN SEVERE INJURY, DEATH OR PROPERTY DAMAGE.**

TO REMOVE FUSE	ATTACH HOT-LINE TOOL TO HOOK EYE AND WITHDRAW FUSEHOLDER STRAIGHT OUT FROM HOUSING
TO REPLACE FUSE	DISASSEMBLE BY UNSCREWING THE FUSE FROM THE INSULATING BAYONET. REPLACE THE BLOWN FUSE WITH A NEW FUSE OF EQUIVALENT RATING AND CHARACTERISTICS. REASSEMBLE BY TIGHTLY SCREWING FUSE ONTO THE INSULATING BAYONET
TO INSTALL FUSE	ATTACH HOT-LINE TOOL TO HOOK EYE AND PLACE FUSEHOLDER INTO HOUSING. PUSH FUSEHOLDER IN FIRMLY UNTIL DUST CAP IS SEATED AGAINST HOUSING AND GROUND CLIP

Fig. 8

EFD LOADBREAK DRAWOUT FUSEHOLDER



WARNING: **ASSEMBLE AND OPERATE FUSEHOLDER PER THESE INSTRUCTIONS. FAILURE TO DO SO CAN RESULT IN SEVERE INJURY, DEATH OR PROPERTY DAMAGE.**

OPERATING INSTRUCTIONS

LOADBREAK ATTACH HOT-LINE TOOL TO HOOK EYE. RAPIDLY WITHDRAW FUSEHOLDER ASSEMBLY COMPLETELY FROM HOUSING.

LOADMAKE ATTACH HOT-LINE TOOL TO HOOK EYE. CAREFULLY POSITION ALIGNMENT RIDGES IN THE CORRESPONDING GROOVES OF THE HOUSING. RAPIDLY PUSH THE ASSEMBLY INTO THE HOUSING UNTIL BASE OF HOOK EYE IS FLUSH WITH HOUSING.

TO REPLACE FUSE ONLY REPL... ...SE WITH FUSEHOLDER WITHDRAWN FROM HOUSING. DISASSEMBLE BY REMOVING THE 4 BR...SS SCREWS AND SHROUD. REPLACE BLOWN FUSE WITH A NEW FUSE OF EQUAL RATING A... CHARACTERISTICS. REASSEMBLE WITH PARTS ORIENTED AS SHOWN. RETIGHTEN THE 4 BRASS SCREWS.

Fig. 9

This device combines the high interrupting capabilities of a general purpose current-limiting fuse with a dry-well fuseholder. The deadbreak drawout is normally mechanically interlocked with a loadbreak switch. Once the transformer is de-energized by operation of the loadbreak switch, the safety baffle may be slid to the side, permitting access to the fuseholder.

To replace the fuse, follow the instructions shown in Figs. 7 and 8.

For futher technical information, refer to ABB TPL 44-837.

9.2.5 Internal Partial Range Current-Limiting Fuse

The internal partial range current-limiting fuse is used in series with a low current interrupting device, such as a protective link or bayonet. The partial range fuse is designed to clear low impedance (high-current) faults, with the explulsion fuse clearing any high impendance faults or overloads. When properly applied, the partial range fuse will only operate for internal transformer faults. Upon operation of a partial range fuse, it is recommended the unit be removed from service and returned to the ABB Power T&D Company Inc. for repair.

9.3 High Voltage Switches

WARNING: **WHEN DE-ENERGIZING THE TRANSFORMER, DO NOT RELY ON SWITCH POSITION OR OTHER VISUAL INDICATORS. ALWAYS ASSUME THAT TERMINALS ARE ENERGIZED UNLESS CHECKED AND GROUNDED. CONTA... WITH AN UNGROUNDED TERMINAL CAN CAUSE ELECTRICAL SHOCK, BURN OR DEATH.**

9.3.1 EFD Switch

The EFD (Externally Fused Disconnect) is an air insulated loadbreak switch available for radial feed (single pole). A general purpose current limiting fuse or a solid blade is provided in the transformer connecting pole. The switch contacts are opened by drawing out the connecting pole so that they are completely free of the switch housing, leaving a visible disconnect.

To operate or replace the fuse, follow the instructions shown in Fig. 9.

9.3.2 LBOR Switch

The ABB LBOR is a gang-operated, two position rotary oil switch. The switch is operated by attaching a hot-line tool to the external hook eye handle and rotating to either the "open" or "closed" position (refer to Fig. 10). Circuit connections are shown on the transformer nameplate.

For further technical information, refer to ABB TPL 44-834.

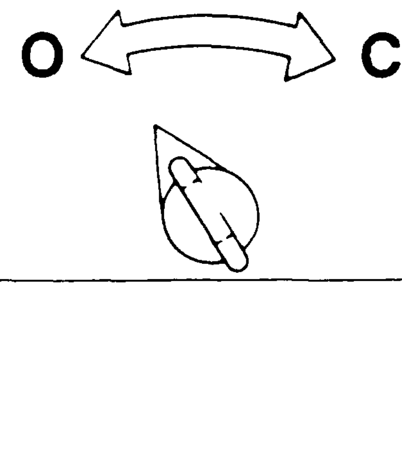


Fig. 10

9.3.3 Tap Changer (Hookstick-operable)

WARNING: DE-ENERGIZE THE TRANSFORMER BEFORE OPERATING THE TAP CHANGER. FAILURE TO DO SO CAN CAUSE SEVERE INJURY, DEATH OR PROPERTY DAMAGE.

The tap changer provides a means of changing the voltage ratio of a transformer. The transformers are normally supplied with an externally operated high voltage tap changer located near the high voltage bushing. To change taps proceed as follows (refer to Fig. 11)

A. De-energize the transformer

B. Back out the locking screw until it is clear of the locking hole

C. Turn the handle to the desired tap position.

D. Tighten the locking screw to minimize the possibility of unintentional movement

Some large-size units are furnished with a power-transformer tap changer drive which requires pulling of a locking pin and a full turn of the handle for each change in tap position

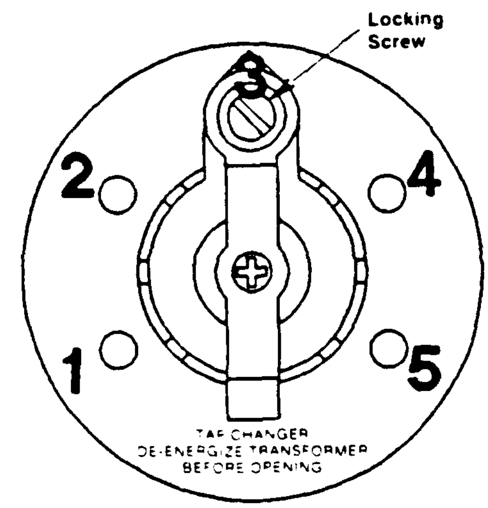


Fig. 11

9.3.4 Dual Voltage Switch (Hookstick-operable)

WARNING: DE-ENERGIZE THE TRANSFORMER BEFORE OPERATING THE DUAL-VOLTAGE SWITCH. FAILURE TO SO DO CAN CAUSE SEVERE INJURY, DEATH OR PROPERTY DAMAGE.

WARNING: WHEN CHANGING VOLTAGE POSITON, FUSES MAY HAVE TO BE REPLACED WITH THOSE OF THE PROPER RATINGS. THE USE OF AN IMPROPERLY RATED FUSE CAN CAUSE SEVERE INJURY, DEATH OR PROPERTY DAMAGE.

On a dual voltage switch Positon 1 is the low or multiple connected position while position 2 is the high or series connected positon. To change the voltage position, proceed as follows (refer to Figure 12)

A. De-energize the transformer

B. Back out the locking screw until it is clear of the locking hole

C. Pull out on the handle until it will rotate

D. Rotate the handle to the new positon

E. Release the handle.

F. Tighten the locking screw to minimize the possibility of unintentional movement

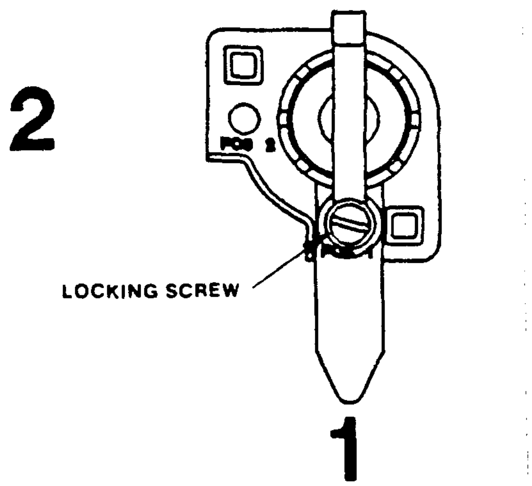


Fig. 12

9.3.5 Arc-Strangler Fused Switch

Arc-Strangler fused switch is mounted in the high voltage compartment. The fused disconnect(s) will have NX current-limiting fuses. Follow the McGraw Edison (Cooper Industries) instructions for operating these devices.

9.3.6 S & C Fused Switch

WARNING: USE THE S & C LOADBUSTER TOOL TO OPERATE THE DISCONNECT. FAILURE TO DO SO CAN CAUSE SEVERE INJURY, DEATH OR PROPERTY DAMAGE.

When an S & C fused switch is used, follow the manufacturer's instructions for operating this equipment. When operated with the S & C loadbuster tool, this disconnect functions as a loadbreak switch.

9.3.7 Surge Arresters

The function of a surge arrester is to intercept and divert to ground various overvoltage transients (such as lightning surges) which occur on the distribution system

The arresters must be disconnected whenever high potential or induced potential tests are made on transformers with arresters

For further technical information, refer to ABB PL 44-921

9.4 Low Voltage Oil-Immersed Circuit Breaker

The low voltage oil-immersed circuit breaker is designed to open the low voltage circuit on secondary faults or excessive overloads. The low voltage breaker is not intended to protect secondary (low voltage) circuits and connected apparatus (meters, service entrance equipment, etc.) from thermal and magnetic effects due to short circuit and overloads. The breaker is primarily a protective device designed for only occasional switching operations, as such it is not intended for frequent (weekly or daily) switching duty. The handle is located in the low voltage compartment and should be operated with a hot-line tool.

CAUTION: WITH THE SECONDARY CIRCUIT OPEN, THERE MAY BE SUFFICIENT COUPLING TO THE WINDING TO CAUSE SHOCK FROM THE SECONDARY TERMINALS. GROUND THE OPEN SECONDARY TERMINALS BEFORE WORKING ON THE SECONDARY SERVICE.

Prior to transformer installation, reset the breaker by opening and closing it as follows (refer to Fig. 13):

- To open the breaker manually, rotate the handle so that the pointer moves from the closed to the open positon.
- To close the breaker, rotate the handle past the open position (to reset the breaker), then back through the open position to the closed position.

If a fault or excessive overload exists, the breaker will trip out even though the handle is held in the closed position.

Following a breaker tripout due to a long term overload, the transformer oil may not have had time to cool sufficiently to allow the breaker latch to be set, making it impossible to reclose the breaker immediately.

CAUTION: AN EMERGENCY CONTROL HANDLE IS PROVIDED TO RECALIBRATE THE BREAKER TO A HIGHER TRIP TEMPERATURE. THIS HANDLE SHOULD BE USED ONLY WHEN ABSOLUTELY NECESSARY AND FOR AS SHORT A DURATION AS POSSIBLE, BECAUSE ITS USE CAN CAUSE A SIGNIFICANT REDUCTION IN TRANSFORMER LIFE.

The breaker can be recalibrated to the emergency position by removing the meter seal and rotating the emergency control handle clockwise. To reset the breaker to its previous setting, return the emergency control handle to the original position. It is recommended that a new seal be applied to the handle when it is returned to the normal position to avoid inadvertent operation of the emergency control.

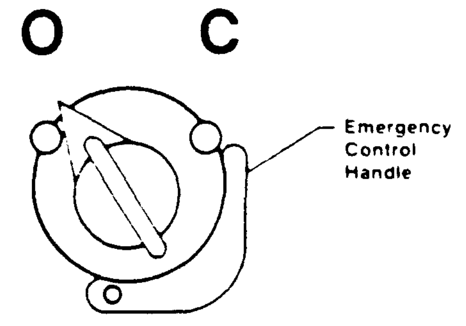


Fig. 13

9.5 Pressure Relief Device

The standard pressure relief device, located on the tank above the liquid level, relieves excessive internal tank pressure and reseals at a lower positive pressure. The pressure relief device is manually operated by grasping the end-cap (or ring, if provided) and slowly pulling the cap away from the tank until pressure is relieved.

9.6 Thermometer

When supplied, a thermometer indicates the liquid temperature near the top of the tank. The temperature sensitive element is mounted in a leakproof well, permitting removal of the thermometer without lowering the liquid level. The device is furnished with an additional pointer, red in color, to show the highest temperature attained since last reset.

9.7 Liquid Level Gauge

When supplied, a liquid level gauge is located in the low voltage compartment to indicate the variation from the 25 degree C liquid level.

9.8 Pressure-Vacuum Gauge

When supplied, a pressure gauge is located in the low voltage compartment above the bushings in the air space. The gauge indicates whether the gas space in the tank is under positive or negative pressure.

9.9 Nameplate

A nameplate is supplied on each transformer according to ANSI standard C57.12.00-1980, Section 5.12. Refer to the nameplate for transformer ratings and for proper connections of the transformer to the system. No internal connections should be made inside the transformer other than those shown on the nameplate.

10.0 MAINTENANCE

A periodic visual inspection of the transformer is recommended. At such times, the general condition of the following should be noted:

A. High voltage bushings
B. Low voltage bushings
C. Arresters (if provided)
D. Enclosure integrity (hinges, locking provisions, corrosion, etc.)
E. Evidence of oil leakage
F. Ground connections
G. Accessories
H. Safety labels
I. Transformer tilt

***WARNING:* WHEN BROKEN PARTS, LEAKING OIL OR OTHER POTENTIALLY HAZARDOUS CONDITIONS ARE OBSERVED, REMOVE THE TRANSFORMER FROM SERVICE UNTIL REPAIRS CAN BE COMPLETED. FAILURE TO DO SO CAN CAUSE SEVERE INJURY, DEATH OR PROPERTY DAMAGE.**

Where tanks show evidence of rusting or deterioration of the finish, they may be cleaned and then retouched with paint available for that purpose. When bare metal is exposed, a primer should initially be applied, then retouching paint applied.

A periodic check of the load should be made to ensure that the transformer is not being subjected to excessive overload. Planned overloading should be in accordance with the ANSI Loading Guide (C57.91).

When adding oil to the transformer, the owner should take the necessary precautions so that PCB contamination is not introduced.

WARNING: OIL SAMPLES SHOULD BE TAKEN FROM THE TRANSFORMER ONLY AFTER DE-ENERGIZING AND MANUALLY VENTING THE TRANSFORMER. FAILURE TO DO SO CAN CAUSE SEVERE INJURY, DEATH OR PROPERTY DAMAGE.

Whenever replacement parts or information regarding existing transformers are required, COMPLETE NAMEPLATE data including KVA rating, STYLE NUMBER, SERIAL NUMBER, and a DESCRIPTION of the part should be given to ABB.

11.0 REPAIR

WARNING: BEFORE ATTEMPTING REPAIRS, DE-ENERGIZE AND VENT THE TRANSFORMER. FAILURE TO DO SO CAN CAUSE SEVERE INJURY, DEATH, OR PROPERTY DAMAGE.

It is the responsibility of the owner to inspect, maintain and keep the transformer in good repair.

Report all failures during the warranty period to your ABB Sales Office. All warranty repairs must be made by ABB or an approved service facility.

To assure proper operation, use only ABB approved replacement parts.

It is recommended that the owner limit repairs to replacing broken parts unless the owner has well-trained repair personnel.

Some internal parts can be replaced without completely draining the tank. In such cases, only the fluid necessary to expose the part should be drained. There may also be occasions when complete draining of the transformer tank will be necessary.

The core and coil assembly can be repaired or replaced by ABB personnel at either the factory or at an authorized repair facility. Refer to Service Policy 46-315 for details, or contact the ABB Power T&D Company Inc.

DISCLAIMER OF WARRANTIES AND LIMITATION OF LIABILITY

THERE ARE NO UNDERSTANDINGS, AGREEMENTS, REPRESENTATIONS OR WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, OTHER THAN THOSE SPECIFICALLY SET OUT BY ANY EXISTING CONTRACT BETWEEN THE PARTIES. ANY SUCH CONTRACT STATES THE ENTIRE OBLIGATION OF SELLER. THE CONTENTS OF THIS DOCUMENT SHALL NOT BECOME PART OF OR MODIFY ANY PRIOR OR EXISTING AGREEMENT, COMMITMENT OR RELATIONSHIP.

The information, recommendations, descriptions and safety notations in this document are based on ABB's experience and judgment with respect to transformers. THIS INFORMATION SHOULD NOT BE CONSIDERED TO BE ALL INCLUSIVE OR COVERING ALL CONTINGENCIES.

NO WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY, OR WARRANTIES ARISING FROM COURSE OF DEALING OR USAGE OF TRADE, ARE MADE REGARDING THE INFORMATION, RECOMMENDATIONS, DESCRIPTIONS AND SAFETY NOTATIONS CONTAINED HEREIN. In no event will ABB be responsible to the user in contract, in tort (including negligence), strict liability or otherwise for any special, indirect, incidental or consequential damage or loss whatsoever including but not limited to damage to or loss of use of equipment, plant or power system, cost of capital, loss of profits or revenues, cost of replacement power, additional expenses in the use of existing power facilities, or claims against the user by its customers resulting from the use of the information, recommendations, descriptions and safety notations contained herein.

DISTRIBUTION LIST

1SG/CEEE / LT MARSH, LANGLEY AFB, VA
92 CES / DEEE, FAIRCHILD AFB, WA
A. TEICHERT & SON, INC / B.T. JOHNSON, SACRAMENTO, CA
ACEC RESEARCH / A.J. WILLMAN, WASHINGTON, DC
ADMINSUPU / PWO, BAHRAIN, FPO AE
AF / AFSC/DEEE, WASHINGTON, DC
AF / MO ANG, 231 CEF/DE (SCHMEDAKE), BRIDGETON, MO
AFB / 82ND ABG/DEMCA, WILLIAMS AFB, AZ
AFIT / DET, WRIGHT PATTERSON AFB, OH
AFIT / DEV, WRIGHT-PATTERSON AFB, OH
AMERICAN SYS ENGRG CORP / M. VIOLANTE, VIRGINIA BEACH, VA
ANTARCTIC / STAFFO, ALEXANDRIA, VA
ARMSTRONG, W. / MYSTIC, CT
ARMY / ENGR CEN, ATSE-DAC-LC, FORT LEONARD WOOD, MO
AR` / KWAJALEIN ATOLL, CSSD-LA-LT, APO AP
ARMY / POJED-O, APO AP
ARMY / QMSCH, ASTM-CDM (JANCZEWSKI), FORT LEE, VA
ARMY CECOM R&D TECH LIBRARY / ASNC-ELC-I-T, FORT MONMOUTH, NJ
ARMY CERL / LIB, CHAMPAIGN, IL
ARMY CRREL / ISKANDAR, HANOVER, NH
ARMY DEPOT / LETTERKENNY, SDSLE-EN, CHAMBERSBURG, PA
ARMY DEPOT / SDSNC-T-MOD-E, NEW CUMBERLAND, PA
ARMY EHA / HSE-RP-HG, ABERDEEN PROVING GROUND, MD
ARMY EHA / HSHB-EA-S, ABERDEEN PROVING GROUND, MD
ARMY EHA / W630, ABERDEEN PROVING GROUND, MD
ARMY ENGRG DIST / SAMEN-DS/DAVIS, MOBILE, AL
ARMY ENGRG DIV / ED-SY (LOYD), HUNTSVILLE, AL
ARMY EWES / LIB, VICKSBURG, MS
ASSOCIATED SCIENTISTS / MCCOY, WOODS HOLE, MA
AU REG HOSP/SGPB / GARG, MAXWELL AFB, AL
BATTELLE NEW ENGLAND MARINE RSCH LAB / LIB, DUXBURY, MA
BECHTEL CIVIL, INC / K. MARK, SAN FRANCISCO, CA
BELV R&DC / COLONEL NEWMAN, FT BELVOIR, VA
BRIT... EMBASSY / SCI & TECH DEPT (WILKINS), WASHINGTON, DC
BUREAU OF RECLAMATION / D-1512 (GS DEPUY), DENVER, CO
CALIFORNIA / FISH & GAME DEPT, LONG BEACH, CA
CALIFORNIA / NAV & OCEAN DEV (ARMSTRONG), SACRAMENTO, CA
CBC / CODE 430, GULFPORT, MS
CBC / CODE 84, PORT HUENEME, CA
CBC / PWO (CODE 400), GULFPORT, MS
CECOS / CODE C35, PORT HUENEME, CA
CHEE, WINSTON / GRETNA, LA
CHEM RP / DEARBORN CHEM DIV LIB, LAKE ZURICH, IL
CITY OF EAST LANSING / N. KING, EAST LANSING, MI
COGUARD / SUPERINTENDENT, NEW LONDON, CT
COLLEGE OF ENGINEERING / CE DEPT (AKINMUSURU), SOUTHFIELD, MI
COM GEN FMF / PAC, SCIAD (G5), CAMP M SMITH, HI
COMDT COGUARD / G-ECV, WASHINGTON, DC
COMNAVLOGPAC / CODE 4318, PEARL HARBOR, HI
COMSUBPAC / CODE 541, SCE, PEARL HARBOR, HI

CONSOER TOWNSEND & ASSOC / DEBIAK, CHICAGO, IL
CONSTRUCTION TECH LABS, INC / G. CORLEY, SKOKIE, IL
DAMES & MOORE / LIB, LOS ANGELES, CA
DEFENSE DEPOT / STRAND, OGDEN, UT
DELAWARE / PUBLIC SAFETY DEPT, DELAWARE CITY, DE
DFSC / F, ALEXANDRIA, VA
DTRCEN / CODE 284, ANNAPOLIS, MD
DTRCEN / CODE 4111, BETHESDA, MD
DTRCEN / CODE 42, BETHESDA, MD
ESSM / WHSE 12 (BOWMAN), WILLIAMSBURG, VA
FACILITIES DEPT / FACILITIES OFFICER, FPO AP
FCTC / LANT, CODE 182, VIRGINIA BEACH, VA
FLORIDA INST OF TECH / CE DEPT (KALAJIAN), MELBOURNE, FL
GARD INC / L B HOLMES, NILES, IL
GEI CONSULTANTS, INC / T.C. DUNN, WINCHESTER, MA
GEOTECHNICAL ENGRS, INC / MURDOCK, WINCHESTER, MA
GLIDDEN CO / RSCH LIB, STRONGSVILLE, OH
GOLDER ASSOC / BRUMUND, ATLANTA, GA
HARBOR BRANCH OCEANOGRAPHIS INSTITUTION / WANG, FORT PIERCE, FL
HARTER, J.V. / METAIRIE, LA
KAISER PERMANENTE MEDCIAL CARE PROGRAM / OAKLAND, CA
KATSURA CONSULTING ENGRS / Y. KATSURA, VENTURA, CA
KLIEGER, PAUL / CE, NORTHBROOK, IL
LEHIGH UNIV / CE DEPT, HYDRAULICS LAB, BETHLEHAM, PA
MARCORBASE / BASE MAINT DEPT, CAMP LEJEUNE, NC
MARCORBASE / CODE 405, CAMP LEJEUNE, NC
MARCORBASE / CODE 406, CAMP LEJEUNE, NC
MARCORBASE / FACILITIES COORDINATOR, CAMP PENDLETON, CA
MARITECH ENGRG / DONOGHUE, AUSTIN, TX
MARITIME ADMIN / MMA, LIB, KINGS POINT, NY
MATRECON, INC / H. HAXO, ALAMEDA, CA
MC CLELLAND ENGRS, INC / LIB, HOUSTON, TX
MCAF / CODE C144, QUANTICO, VA
MCLB / CODE 506, ALBANY, GA
MCLB / CODE 555, ALBANY, GA
MCRDAC / M & L DIV, QUANTICO, VA
MIT / R.V. WHITMAN, CAMBRIDGE, MA
NAF / PWO, FPO AP
NAF / SO, EL CENTRO, CA
NALF / OIC, SAN DIEGO, CA
NAS / CODE 110, FPO AP
NAS / CODE 163, KEFLAVIK, ICELAND, FPO AE
NAS / CODE 421, SAN DIEGO, CA
NAS / CODE 504, SAN DIEGO, CA
NAS / CODE 6201 (CORRIGAN), POINT MUGU, CA
NAS / CODE 721, NEW ORLEANS, LA
NAS / CODE 83, PATUXENT RIVER, MD
NAS / KOBAYASHI, CODE 703, LONG BEACH, CA
NAS / MIRAMAR, SAN DIEGO, CA
NAS / MIRAMAR, PWO, SAN DIEGO, CA
NAS / P&E SUPR, FPO AP
NAS / PW ENGRG, PATUXENT RIVER, MD
NAS / PWD MAINT DIV, NEW ORLEANS, LA

NAS / PWO, MOFFETT FIELD, CA
NAS / PWO, MERIDIAN, MS
NAS / SCE, FPO AP
NAS / SCE, NORFOLK, VA
NAS / TREASURE ISLAND, CODE 84, SAN FRANCISCO, CA
NAS / WHITING FLD, PWO, MILTON, FL
NAS / WPNS OFFR, ALAMEDA, CA
NAS MEMPHIS / CODE N-81, MILLINGTON, TN
NAS NPWC / CODE 102 (J. ARESTO), SAN DIEGO, CA
NAS PENSACOLA / FAC MGMT OFFICER, PENSACOLA, FL
NATL ACADEMY OF ENGRY / ALEXANDRIA, VA
NAVAIRDEVCEN / CODE 832, WARMINSTER, PA
NAVAIRPROPCEN / CODE PW-3, TRENTON, NJ
NAVAL ED & TRAIN CEN / UTIL DIR, NEWPORT, RI
NAVAUDSVCHQ / DIR, FALLS CHURCH, VA
NAVAVIDEPOT / CODE 904, NORFOLK, VA
NAVAVIONICCEN / PWO, INDIANAPOLIS, IN
NAVAVNDEPOT / CODE 011, NORFOLK, VA
NAVAVNDEPOT / CODE 61000, CHERRY POINT, NC
NAVCAMS / WESTPAC, SCE, FPO AP
NAVCOASTSYSCEN / CODE 423, PANAMA CITY, FL
NAVCOMMSTA / PWO, THURSO, UK, FPO AE
NAVCONSTRACEN / CODE D2A, PORT HUENEME, CA
NAVDIVESALVTRACEN / CO, PANAMA CITY, FL
NAVENVIRHLTHCEN / CODE 42, NORFOLK, VA
NAVFAC / N62, ARGENTINA, NF, FPO AE
NAVFAC CENTERVILLE BEACH / FERNDALE, CA
NAVFACENGCOM / CODE 04A3, ALEXANDRIA, VA
NAVFACENGCOM / CODE 04A4E, ALEXANDRIA, VA
NAVFACENGCOM / CODE 051A, ALEXANDRIA, VA
NAVFACENGCOM / CODE 083, ALEXANDRIA, VA
NAVFACENGCOM / CODE 183 (GEBHART), ALEXANDRIA, VA
NAVFACENGCOM CHESDIV / CODE 04, WASHINGTON, DC
NAVFACENGCOM CHESDIV / CODE 114.1, WASHINGTON, DC
NAVFACENGCOM CHESDIV / YACHNIS, WASHINGTON, DC
NAVFACENGCOM CONTRACTS / ROICC, POINT MUGU, CA
NAVFACENGCOM CONTRACTS / ROICC, SANTA ANA, CA
NAVFACENGCOM LANTDIV / CODE 405, NORFOLK, VA
NAVFACENGCOM NORTHDIV / CO, PHILADELPHIA, PA
NAVFACENGCOM NORTHDIV / CODE 202.2, PHILADELPHIA, PA
NAVFACENGCOM SOUTHDIV / CODE 04A, CHARLESTON, SC
NAVFACENGCOM SOUTHWESTDIV / CODE 101.1, SAN DIEGO, CA
NAVFACENGCOM SOUTHWESTDIV / CODE 1812, SAN DIEGO, CA
NAVFACENGCOM WESTDIV / CODE 102, SAN BRUNO, CA
NAVFACENGCOM WESTDIV / CODE 1833, SAN BRUNO, CA
NAVFACENGCOM WESTDIV / PAC NW BR OFFC, CODE C/42, SILVERDALE, WA
NAVFACENGCOM WESTDIV / ROICC, SILVERDALE, WA
NAVFACENGCOM WESTDIV / VALDEMORO, SAN BRUNO, CA
NAVFUEL DET / OIC, FPO AP
NAVMAG / CODE 09, LUALUALEI, HI
NAVMAG / SCE, FPO AP
NAVMEDCLINIC / HEAD, INDUST HYGIENE DIV, PEARL HARBOR, HI
NAVMEDCOM / NWREG, FAC ENGR, PWD, OAKLAND, CA

NAVMEDRSCHINSTITUTE / CODE 47, BETHESDA, MD
NAVOCEANO / LIB, NSTL, MS
NAVORDMISTESTSTA / CODE 40, WHITE SANDS MISSILE RANGE, NM
NAVORDSTA / INDIAN HEAD DET, MCALESTER, OK
NAVORDSTA / PWO, LOUISVILLE, KY
NAVPETOFF / SEC OFFR (CODE 20), ALEXANDRIA, VA
NAVPGSCOL / E. THORNTON, MONTEREY, CA
NAVPWC / TAYLOR, PENSACOLA, FL
NAVSCSCOL / PWO, ATHENS, GA
NAVSEACENPAC / CODE 420, SAN DIEGO, CA
NAVSEASYSCOM / CODE 51412, WASHINGTON, DC
NAVSECGRU / CODE G43, WASHINGTON, DC
NAVSECGRUACT / CODE 31 PWO, FPO AA
NAVSECGRUACT / PWO (CODE 40), EDZELL, SCOTLAND, FPO AE
NAVSECGRUACT / PWO, CHESAPEAKE, VA
NAVSECSTA / CODE 60, WASHINGTON, DC
NAVSECSTA / CODE N70, WASHINGTON, DC
NAVSHIPREPFAC / SCE, FPO AP
NAVSHIPYARD / CODE 383.4, PORTSMOUTH, VA
NAVSHIPYD / CODE 106.4 STARYNSKI, PHILADELPHIA, PA
NAVSHIPYD / CODE 202.5 LIB, BREMERTON, WA
NAVSHIPYD / CODE 308.3, PEARL HARBOR, HI
NAVSHIPYD / CODE 450, BREMERTON, WA
NAVSHIPYD / MARE IS, CODE 440, VALLEJO, CA
NAVSHIPYD / SCE (CODE 308.2), PEARL HARBOR, HI
NAVSHIPYD / TECH LIB, PORTSMOUTH, NH
NAVSTA / CBU-422, WASHINGTON, DC
NAVSTA / CODE ODA2, SAN DIEGO, CA
NAVSTA / DIR, ENGR DIV, PWD, GUANTANAMO BAY, CUBA, FPO AE
NAVSTA / ENVIR, STATEN ISLAND, NY
NAVSTA / PWO, ROTA, SPAIN, FPO AE
NAVSTA / TREASURE IS, SO, SAN FRANCISCO, CA
NAVSTA / UTIL ENGRG OFFR, ROTA, SPAIN, FPO AE
NAVSTA PUGET SOUND / CODE 922, EVERETT, WA
NAVSUPCEN / CODE 700A.1, NORFOLK, VA
NAVSUPPACT / PWO, NAPLES, ITALY, FPO AE
NAVSUPPO / SEC OFFR, LA MADDALENA, ITALY, FPO AE
NAVSWC / CODE C83, DAHLGREN, VA
NAVSWC / CODE W42 (GS HAGA), DAHLGREN, VA
NAVSWC / DET, WHITE OAK LAB, CODE W50, SILVER SPRING, MD
NAVSWC / DET, WHITE OAK LAB, PWO, SILVER SPRING, MD
NAVSWC / P O, DAHLGREN, VA
NAVTECHTRACEN / UPSON, PENSACOLA, FL
NAVTRASTA / PWO, ORLANDO, FL
NAVWPNCEN / CODE 2405, CHINA LAKE, CA
NAVWPNCEN / CODE 2637, CHINA LAKE, CA
NAVWPNSTA / CODE 092, CONCORD, CA
NAVWPNSTA / CODE 092, SEAL BEACH, CA
NAVWPNSTA / PWO, YORKTOWN, VA
NAVWPNSTA EARLE / CODE 092, COLTS NECK, NJ
NCR / 20, CODE R70, GULFPORT, MS
NEESA / CODE 113M, PORT HUENEME, CA
NIEDORODA, AW / GAINESVILLE, FL

NIST / BLDG TECH, MCKNIGHT, GAITHERSBURG, MD
NOAA / DIR, PAC MARINE CEN, SEATTLE, WA
NORDA / CODE 352, NSTL, MS
NORTHDIV CONTRACTS OFFICE / ROICC, PORTSMOUTH, NH
NOSC / CODE 94, SAN DIEGO, CA
NRL / CODE 2530.1, WASHINGTON, DC
NRL / CODE 6123, WASHINGTON, DC
NSC / CODE 02, PEARL HARBOR, HI
NSC / CODE 43, OAKLAND, CA
NSC / CODE 70, OAKLAND, CA
NUSC DET / CODE 0261, NEW LONDON, CT
NUSC DET / CODE 52, NEW LONDON, CT
NUSC DET / CODE 5202 (SCHADY), NEW LONDON, CT
OAS / MCCONAHY, ARLINGTON, VA
PACIFIC MARINE TECH / M. WAGNER, DUVALL, WA
PAULI, DC / SILVER SPRING, MD
PILE BUCK, INC / SMOOT, JUPITER, FL
PODELL, H.I. / NEW ROCHELLE, NY
PWC / CODE 101, GREAT LAKES, IL
PWC / CODE 1013, OAKLAND, CA
PWC / CODE 110, OAKLAND, CA
PWC / CODE 420, OAKLAND, CA
PWC / CODE 421 (KIMURA), PEARL HARBOR, HI
PWC / CODE 500, SAN DIEGO, CA
PWD / ENGR DIRECTOR, CORPUS CHRISTI, TX
SARGENT & HERKES, INC / JP PIERCE, JR, NEW ORLEANS, LA
SEATTLE PORT / DAVE VAN VLEET, SEATTLE, WA
SHANNON & WILSON, INC / LIB, SEATTLE, WA
SPCC / CODE 082, MECHANICSBURG, PA
STATE UNIV OF NEW YORK / CE DEPT, BUFFALO, NY
SUBASE / SCE, PEARL HARBOR, HI
SURFACE COMBUSTION / V.R. DAIGAN, MAUMEE, OH
TEXAS A&M UNIV / CE DEPT (HERBICH), COLLEGE STATION, TX
TEXAS A&M UNIV / CE DEPT (SNOW), COLLEGE STATION, TX
TEXAS A&M UNIV / ENERGY TRNG DIV (DONALDSON), HOUSTON, TX
TEXAS A&M UNIV / OCEAN ENGR PROJ, COLLEGE STATION, TX
THE KLING-LINDQUIST, INC / RADWAN, PHILADELPHIA, PA
TRIDENT TRAINING FAC / ANDERSON, KINGS BAY, GA
UNITED TECHNOLOGIES / LIB, WINDSOR LOCKS, CT
UNIV OF NEW MEXICO / NMERI (FALK), ALBUQUERQUE, NM
UNIV OF PENNSYLVANIA / INST ENVIRON MEDICINE, PHILADELPHIA, PA
UNIV OF RHODE ISLAND / DR. VEYERA, KINGSTON, RI
UNIV OF WASHINGTON / ENGRG COL (CARLSON), SEATTLE, WA
US DEPT OF HHS / FDA (FISHERY RSCH BR), DAUPHIN ISLAND, AL
US DEPT OF INTERIOR / BLM, ENGRG DIV (730), WASHINGTON, DC
US GEOLOGICAL SURVEY / J BALES, RALEIGH, NC
US GEOLOGICAL SURVEY / MARINE GEOLOGICAL OFFC, RESTON, VA
USACOE / CESPD-CO-EQ, SAN FRANCISCO, CA
USDA / FOR SVC, EQUIP DEV CEN, SAN DIMAS, CA
USN / CAPT COLIN M JONES, HONOLULU, HI
USNA / SYS ENGRG, ANNAPOLIS, MD
VEDA / SUTTON, OAKLAND, CA
VENTURA COUNTY / PWA (BROWNIE), VENTURA, CA

VIATEUR DE CHAMPLAIN / INST OF MARITIME ENGRG, MATANE, QUEBEC
VSE / OCEAN ENGRG GROUP (MURTON), ALEXANDRIA, VA
WASTE-TECH SVCS / ENVIRON DIR (COOPER), GOLDEN, CO
WESTERN ARCHEOLOGICAL CEN / LIB, TUCSON, AZ
WESTINGHOUSE ELECTRIC CORP / LIB, PITTSBURG, PA
WOODWARD-CLYDE CONSULTANTS / R. CROSS, OAKLAND, CA

DISTRIBUTION QUESTIONNAIRE

The Naval Civil Engineering Laboratory is revising its primary distribution lists.

SUBJECT CATEGORIES

1 **SHORE FACILITIES**
1A Construction methods and materials (including corrosion control, coatings)
1B Waterfront structures (maintenance/deterioration control)
1C Utilities (including power conditioning)
1D Explosives safety
1E Aviation Engineering Test Facilities
1F Fire prevention and control
1G Antenna technology
1H Structural analysis and design (including numerical and computer techniques)
1J Protective construction (including hardened shelters, shock and vibration studies)
1K Soil/rock mechanics
1L Airfields and pavements
1M Physical security
2 **ADVANCED BASE AND AMPHIBIOUS FACILITIES**
2A Base facilities (including shelters, power generation, water supplies)
2B Expedient roads/airfields/bridges
2C Over-the-beach operations (including breakwaters, wave forces)
2D POL storage, transfer, and distribution
2E Polar engineering
3 **ENERGY/POWER GENERATION**
3A Thermal conservation (thermal engineering of buildings, HVAC systems, energy loss measurement, power generation)
3B Controls and electrical conservation (electrical systems, energy monitoring and control systems)
3C Fuel flexibility (liquid fuels, coal utilization, energy from solid waste)
3D Alternate energy source (geothermal power, photovoltaic power systems, solar systems, wind systems, energy storage systems)
3E Site data and systems integration (energy resource data, integrating energy systems)
3F EMCS design
4 **ENVIRONMENTAL PROTECTION**
4A Solid waste management
4B Hazardous/toxic materials management
4C Waterwaste management and sanitary engineering
4D Oil pollution removal and recovery
4E Air pollution
4F Noise abatement
5 **OCEAN ENGINEERING**
5A Seafloor soils and foundations
5B Seafloor construction systems and operations (including diver and manipulator tools)
5C Undersea structures and materials
5D Anchors and moorings
5E Undersea power systems, electromechanical cables, and connectors
5F Pressure vessel facilities
5G Physical environment (including site surveying)
5H Ocean-based concrete structures
5J Hyperbaric chambers
5K Undersea cable dynamics
ARMY FEAP
BDG Shore Facilities
NRG Energy
ENV Environmental/Natural Responses
MGT Management
PRR Pavements/Railroads

TYPES OF DOCUMENTS

D – Techdata Sheets; **R** – Technical Reports and Technical Notes; **G** – NCEL Guides and Abstracts; **I** – Index to TDS; **U** – User Guides; ☐ None - remove my name

Old Address:

____

____

____

____

Telephone No.: ________________

New Address:

____

____

____

____

Telephone No.: ________________

INSTRUCTIONS

The Naval Civil Engineering Laboratory has revised its primary distribution lists. To help us verify our records and update our data base, please do the following:

- Add - circle number on list
- Remove my name from all your lists - check box on list.
- Change my address - line out incorrect line and write in correction **(DO NOT REMOVE LABEL).**
- Number of copies should be entered after the title of the subject categories you select.
- Are we sending you the correct type of document? If not, circle the type(s) of document(s) you want to receive listed on the back of this card.

Fold on line, staple, and drop in mail.

DEPARTMENT OF THE NAVY
Naval Civil Engineering Laboratory
560 Laboratory Drive
Port Hueneme CA 93043-4328

Official Business
Penalty for Private Use, $300

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY CARD

FIRST CLASS PERMIT NO. 12503 WASH D.C.

POSTAGE WILL BE PAID BY ADDRESSEE

COMMANDING OFFICER
CODE L34
560 LABORATORY DRIVE
NAVAL CIVIL ENGINEERING LABORATORY
PORT HUENEME CA 93043-4328

NCEL DOCUMENT EVALUATION

You are number one with us; how do we rate with you?

We at NCEL want to provide you our customer the best possible reports but we need your help. Therefore, I ask you to please take the time from your busy schedule to fill out this questionnaire. Your response will assist us in providing the best reports possible for our users. I wish to thank you in advance for your assistance. I assure you that the information you provide will help us to be more responsive to your future needs.

R. N. STORER, Ph.D, P.E.
Technical Director

DOCUMENT NO. __________ TITLE OF DOCUMENT: ______________________________

____

Date: __________ Respondent Organization : ______________________________

Name: ______________________________ Activity Code: ______________________

Phone: ______________________________ Grade/Rank: ______________________

Category (*please check*):

Sponsor _____ User _____ Proponent _____ Other (*Specify*) ______________________

Please answer on your behalf only; not on your organization's. Please check (*use an X*) only the block that most closely describes your attitude or feeling toward that statement:

SA Strongly Agree A Agree O Neutral D Disagree SD Strongly Disagree

---

	SA	A	N	D	SD
1. The technical quality of the report is comparable to most of my other sources of technical information.	( )	( )	( )	( )	( )
2. The report will make significant improvements in the cost and or performance of my operation.	( )	( )	( )	( )	( )
3. The report acknowledges related work accomplished by others.	( )	( )	( )	( )	( )
4. The report is well formatted.	( )	( )	( )	( )	( )
5. The report is clearly written.	( )	( )	( )	( )	( )
6. The conclusions and recommendations are clear and directly supported by the contents of the report.	( )	( )	( )	( )	( )
7. The graphics, tables, and photographs are well done.	( )	( )	( )	( )	( )

Do you wish to continue getting NCEL reports? ☐ YES ☐ NO

Please add any comments (e.g., in what ways can we improve the quality of our reports?) on the back of this form.

Comments:

Fold on line, staple, and drop in mail.

DEPARTMENT OF THE NAVY
Naval Civil Engineering Laboratory
560 Laboratory Drive
Port Hueneme CA 93043-4328

Official Business
Penalty for Private Use, $300

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY CARD

FIRST CLASS PERMIT NO. 12503 WASH D.C.

POSTAGE WILL BE PAID BY ADDRESSEE

COMMANDING OFFICER
CODE L03
560 LABORATORY DRIVE
NAVAL CIVIL ENGINEERING LABORATORY
PORT HUENEME CA 93043-4328